Industrial QUALITY CONTROL

VOL. V JULY, 1948 NO. 1

Professor Fred Mosteller of Harvard and Edward A. Reynolds of Syracuse discuss with Martin Brumbaugh current trends in penicillin production while visiting Bristol Laboratories.

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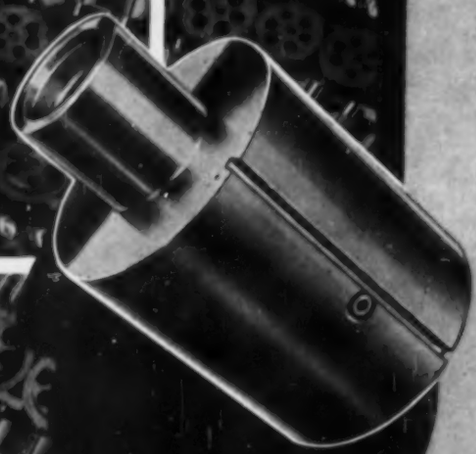

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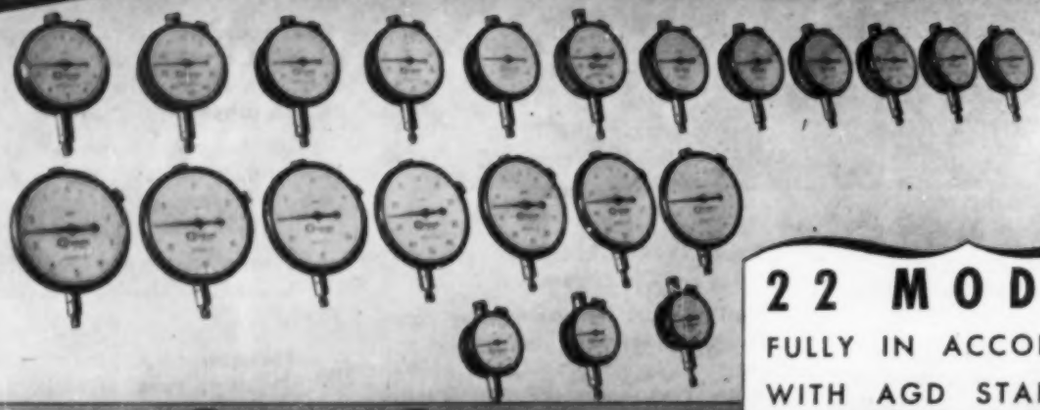

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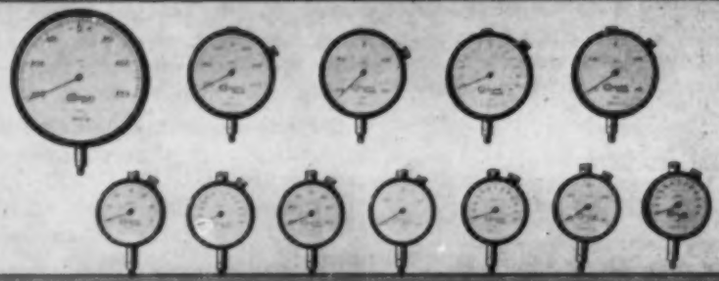

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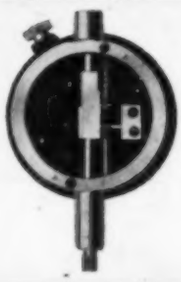

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PREVIEW
THIRD MIDWEST QUALITY CONTROL CONFERENCE

Plans for the Third Midwest Quality Control Conference are shaping up rapidly. The full Planning Committee has been meeting regularly for almost a year, and the largest part of the groundwork has been laid.

Eight midwest ASQC Sections are sponsoring the Conference, which will be held at the Hotel Sherman in Chicago on November 4 and 5, 1948. Under the general chairmanship of James M. Ballowe of Aldens, Inc., all committees have been active and only last minute details remain to be planned.

Professor Lloyd A. Knowler of the University of Iowa, Chairman of the Program Committee, has completed an excellent roster of speakers for both the clinic and the training sessions. Highlighting the Conference program will be the luncheon sessions at which two top-ranking business executives will give down-to-earth talks on the benefits of statistical quality control applications in their plants.

On the first day, Colonel Charles D. Wiman, President of Deere & Company, will be the luncheon speaker, while the second luncheon meeting will feature Mr. Hugo A. Weissbradt, Works Manager of International Harvester's Fort Wayne Motor Truck Division.

No dinner meeting is planned for this Conference.

The Conference will also feature a Gage Exhibits, at which the latest devices for measurement and control will be demonstrated.

Complete details of the Conference will appear in the September issue of INDUSTRIAL QUALITY CONTROL, but plan now to be at these meetings in Chicago on Thursday, November 4, and Friday, November 5.

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Industrial Quality Control

VOL. V JULY, 1948 NO. 1

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The Care and Feeding of a Quality Program*

W. K. McHENRY, Jr.

ELECTRICAL PRODUCTS DIVISION, CORNING GLASS WORKS

The title of this paper suggested itself because of the many respects in which a Quality program in an industrial plant requires the same tender care and attention given to a baby. In the course of the paper I shall try to show how the introduction of a program of statistical quality control presents as many problems for the Quality man as the care of a new-born babe makes for a young mother.

First of all, there's the preparation of the formula, which must be simple enough to be digestible. Next comes the feeding schedule which must be rigidly adhered to if proper nourishment is to be obtained. More likely than not, the formula or schedule — or both — must be adjusted as the capacity for digestion increases. Sometimes the quality approach and the baby may have to be changed. The thoughts and experiences presented here are purely from the standpoint of selling and administering a quality program. Let us begin with a brief background of the company I represent.

Corning Glass Works, now in its 97th year, has long been the leading manufacturer of technical glass products. The American housewife thinks of Corning in terms of PYREX brand Ovenware and top-of-stove Flameware, which she uses in the preparation of her daily meals. Electrical manufacturers know Corning as a major supplier of incandescent bulb blanks, fluorescent and signlite tubing, radio and television tubes and parts. Food and chemical processors look to Corning for heat-and-acid resistant PYREX piping. The optical industry engaged in the production of single-vision and bi-focal eyeglasses, uses Corning's Ophthalmic glass. Now, for the first time, Ophthalmic glass is being produced by automatic methods. Connoisseurs of the world's finest crystal find it in the Steuben Shop on New York's Fifth Avenue where Corning-made Steuben art and stemware are offered for sale.

In short, our products range from the 200-inch telescope reflecting mirror soon to be placed in operation on Mt. Palomar, to the recently announced photo sensitive glass that makes permanent, 3-dimensional recordings of pictures in glass.

Organization-wise our company is divided into three product divisions: Technical Products, Consumer Products, and Electrical Products. I speak only for one Division. Our **staff group** operates within the last named division, Electrical Products, which manufacures and sells parts for the lamp, radio, television, and signlite industries. Our staff, which reports to the Product Engineering and Standardization Manager, is small but well balanced, including in particular, a man with years of practical production and inspection experience gained in the plant, and a statistician who in addition to scientifc mathematical training has a great deal of imagination and valuable experience. Each of these men has one most important asset in common with the other, namely, the ability to get along well with people.

While Corning has a total of twelve manufacturing plants, each with its own line quality manager, only seven of these plants manufacture Electrical Products. Only three plants are supervised directly by our division management. The function of our divisional staff group is to assist each of our three line quality groups, to authorize disposition of rejected ware and credits, to investigate complaints, to study inspection methods, to study customer requirements, to recommend procedures and methods designed to properly "tailor" our outgoing quality levels to customer needs, consistent with the economics involved.

I do not mean to imply that we make unwise compromises with respect to quality. But we believe that there is a relation between quality and price which should not be overlooked or disregarded.

As I have read, or listened to, the experiences of a number of quality people, who like ourselves, have helped introduce statistical quality control techniques into industry, I have become acutely aware of a **real** advantage that we, in Corning, have had over some others. That is a top management sympathetic to quality control, willing to believe it can work and willing to give us time to prove it. It has not been necessary to **sell** management. Approximately twenty people, (seven from our division), have been sent to the several universities that have sponsored ten-day intensive courses in statistical quality control. My introduction to it came in May 1945 at the State University of Iowa. Shortly thereafter, Corning Glass Works introduced a company-wide quality campaign to make employees at all levels quality-conscious. Its theme was "Quality Protects Your Job." A series of

*Paper given April 3, 1948, at the Intensive Training Course sponsored by the St. Louis Section, ASQC, and Washington University, St. Louis, Mo.

letters to all employees at their homes from the President, banners, posters, membership cards in the "Quality Corps" and quality lapel buttons for all employees were utilized. And so, the good ship "Quality" was launched, and slid down the "ways" built by management. But once in the water, it became "our baby"!

I do not wish to imply that this campaign marked the introduction of quality at Corning Glass Works, for, as long ago as 1925 the company, along with one of its larger lamp customers, retained the Electrical Testing Laboratories in conducting independent inspections of packed ware in our plants. A few years later, when this customer felt it could no longer carry its share of this inspection expense, Corning assumed the entire cost, bought the testing equipment outright, and brought most of the Electrical Testing representatives who had been working in our plants into the permanent employ of our company. Corning did this because it was convinced of the value to itself and to its customers of a scientific check inspection system.

Corning also foresaw that postwar markets would be highly competitive, with customers demanding better and better quality at no increase in prices. To meet this problem, the company undertook a long-range program of establishing a system of over-all process control, realizing that Quality is something that is built into a product, not inspected into it.

Our "Baby" was beginning to grow, and his "formula" needed changing. The "formula" in this case called for the introduction of quality control methods at the machine, the actual point of manufacture. Once a piece of glass has been made, and made incorrectly, it cannot be reworked; and all the inspection in the world will not change a poor glass product into a good one. To veteran glass makers—men who had grown up in the business and who operated by rule of thumb—statistical quality control procedures were a new thing and were looked upon with distrust and suspicion. Remember how mothers defended the triangular, or three corner diapers? What could a man like McHenry, who had never before been inside a glass plant tell them about improving their operations? How could we approach men who were already making high quality ware and hope to introduce scientific controls that would even further improve quality and production? To be perfectly frank, we failed completely on our first attempt. And we failed because in our enthusiasm to get things started, we completely disregarded one of the most important principles that we had been taught in the course we attended at Iowa University. We forgot to **proceed with caution.**

We set up a system of process control at a machine but we did so without first explaining to the operators exactly what we were doing and why we were doing it. Since the operators weren't **told,** they weren't **sold.** In our haste, we had neglected to train inspectors. We had no alternative but to withdraw. Our "formula" was OK but our **method** of feeding was **too fast.**

The next time we were more successful. We first of all called a meeting of all the people who would work with the new system. We found them more than a little antagonistic, and, looking back now, I can readily understand their attitude. This plant had long been delivering good quality, which made our job all the more difficult. (It's much easier to improve poor quality than it is to improve good quality). We soothed their resentment by frankly admitting that the quality of the ware they were making was known to be high, and that our process control methods would not alone, improve existing quality. But, we showed them how the new controls could reduce costs of production and inspection and reduce existing chances of wrongly estimating quality, or percent defective.

When our methods were introduced the second time, they were put in parallel with the established system of inspection of packed ware. It was not until the new method had proved itself, and until the inspectors and operators were convinced of its superiority, that we abandoned the old system.

We have had, I am sure, experiences common to all quality control groups. To many **glass** men, the making and fabricating of glass was, and is, an art, not a science. I will venture to say that any pioneer (so to speak) in quality control in **any** industry may likely learn that to any industry its own problems seem unique. We believe statistical quality control principles can be applied to any repetitive process. Is it not because no two things can be made exactly alike that the need for the tool, statistical methods of quality control, was recognized? We have made mistakes, but we **learned** from them. We have installed control chart systems and have later realized to our dismay, as previously admitted, that we overlooked the fundamentally important rule that all the people dealing with not only inspection, but also production, should first be made thoroughly familiar, in clear simple terms, with **what** was being done ,and for what **purpose.**

Such recollections have prompted me to choose the subject "The Care and Feeding of a Quality Program." We try not to repeat our errors. I cannot stress too strongly the importance of listening, with respect and patience to experienced men in production and inspection work: **practical** men can add importantly to our education. As yet, no substitute has been found for **experience.** Furthermore, Statistical Quality Control as treated in most text bocks lacks one essential characteristic: **simplicity.** The man who must sell and administer the program within industry must speak in clear, simple terms to the uninitiated so that people, even such as I, can understand, appreciate, and find a yearning for more learning.

From the "now it can be told" department there comes to mind an experience worth relating. When I returned from Iowa, where in ten days I had "learned **all** about quality control," I was most anxious to tell others in the company of the almost limitless scope of possible uses for the theories. A meeting was arranged in one of the plants, attended by about twenty production and quality supervisors. My theme was "Sta-

tistical Quality Control Made Simple." I had before hand chalked on a blackboard the formula for computing standard deviation, or "sigma."

My purpose was mere reference to the formula, and I intended to brush it aside as being unnecessarily complicated for practical use. Then I intended to point with smug satisfaction to the tables of factors for computing control limits that have been developed by competent mathematicians and are readily available for use. It might have been done successfully, if I had not made the unfortunate error of incorrectly arranging the formula on the blackboard; and if Fate had not placed in the audience a man who knew enough about mathematics to see the error, and who lost no time in calling it to everyone's attention! After the smoke cleared, and my cheeks had returned to their more normal color, we got along quite well, but never have I experienced more uncomfortable moments.

We arrange as many such meetings as often (but no more often) as is necessary. They point toward better understanding b e t w e e n sales, engineering, production, and quality people. In addition, we are currently engaged in arranging training courses for inspectors; simple short sessions, intended to educate new inspectors and refresh experienced ones. We have made it a practice to contact the quality, purchasing, and production people in our customers' plants, and this has helped us to understand each other's needs and problems. We have developed a number of acceptance sampling arrangements with and for customers. Today we notice a marked trend away from incoming inspection. This is encouraging to us, for it means that these customers have gained considerable confidence in our ability to maintain uniform levels of quality.

Several years ago one of our larger customers developed a form of incoming acceptance sampling that seemed at first to be satisfactory to them and to our manufacturing group. However, after we gained a speaking acquaintance with the laws of probability, and sampling risks, we began to have doubts about that arrangement. We referred the problem to the statistician who was added to our group at about that time, and he was quickly able to confirm our suspicions. Under the then existing sampling arrangement, very poor quality could be accepted a high percentage of the time. It was not our desire to have large consumer risks involved, so we suggested a new arrangement which offered the customer more protection, and it was promptly adopted. Our voluntary action impressed the customer favorably, and relations along all fronts have since grown steadily better. The same customer has recently notified us that, due to his observation of the quality of lots shipped in the past six months, he has decided to reduce his incoming inspection 75%. Eventually, he hopes to reduce costs further by eliminating acceptance inspection entirely.

Another customer's records reveal that in 1947 he was able to successfully fabricate into lamps over 99% of all ware we shipped him—exclusive, of course, of transit breakage. No incoming inspection is performed by that organization.

It may be surprising to learn that due to customer requirements and the peculiar characteristics of glass, it is possible for 63 different things to be wrong with a single frosted bulb. This, in turn, gives some idea of the extreme care with which specifications must be prepared and followed. For example, specification tolerances for measureable characteristics in our automatic machine-made bulbs are in the order of 0.010" to 0.020". One of the most important requirements is neck wall thickness, and permissible variation. It is vital to our customers that uniform thickness, within relatively close limits, be maintained. Their operation, that of making lamps from our bulbs, is also a high-speed operation. Excessive variation would seriously reduce their production speed, thereby increasing their costs.

For example, a neck wall specification at the lamp sealing position may be 0.018" minimum and 0.032" maximum. However, the maximum neck wall thickness in any individual bulb may not exceed its minimum by more than 60%. In the same bulb, if the minimum is 0.018" and maximum is 0.032", the difference is 0.014", or 77% of minimum 0.018". If the minimum is 0.018", maximum may not be more than 0.028"; with minimum 0.020", maximum may be 0.032".

It has been said that in no other product selling for 11¢, can the public buy engineering and material comparable to that found in an incandescent lamp. This technical background is the result of nearly 70 years of research and development that began one day back in 1879 when a Corning Glass Works "gaffer" blew the glass for Edison's first incandescent lamp. Just in passing, we may note that Corning continued to make all bulbs by hand until well after the turn of the century. Many special types are made by hand today. The most highly skilled gaffers used to turn out from 1200 to 1400 bulbs a day. Today, on the Corning-developed "ribbon - machine," we can turn out this same number of bulbs in two minutes or less.

We use an adaptation of a percent defective control chart system for recording visual faults at the machine on a number of processes manufacturing both bulbs and tubing. At the same time, measurable faults are controlled by $\overline{X}$ and R charts. There is nothing about our techniques that is so significantly different from other familiar applications as to justify going into further detail. We point with pride, however, to records of increased production of good ware, and reductions in amounts of reinspection or re-work, due, in part, to process control, and in part to willingness of operators to make machine adjustments only when the charts indicated action as necessary.

'Twas not ever thus, for we remember a trial application of chart control operation on a high-speed machine that was conducted in parallel with existing methods of inspection control. The operator had been told about the trial, and told about our intention of showing him how we could help him attain better volume of better ware. We asked him to co-operate by making adjustments on the machine only when we signalled (by means of a telautograph system). In turn we were to be prompted by the pattern developed on the chart of the plotted averages of samples taken from the conveyor belt. After a few hours spent in

watching a somewhat erratic photograph of the process develop on the chart, we decided it would be well to discuss it with the operator, to show him how the chart could have predicted the approach of lack of control, and to show him when the machine **did** go out of control. Just as we approached, we found him with one bulb, measuring wall thickness with a gauge, and ready to explain, as he did, that "by golly" he had made an overadjustment. He had made that decision on the basis of measuring that single bulb. Obviously, our preliminary sales-talk had not been effective.

We were confronted with a major problem with respect to getting the control chart placed where the operator of the machine could see it. Due to existing operating conditions, noise, heat and possible danger of flying hot glass, the inspector was forced to sit some distance away from the operator's position. This problem has been solved by an ingenious adaptation of an electric temperature control set-up.

Another application of statistical quality control techniques of interest to us concerns the control of the outside diameter of a popular-size of tubing. For years tubing, generally, was sold in gauge sizes. One full-gauge size was broken down into four quarter-gauge sizes, and the tubing measured on an automatic gauging machine. It was then sorted, bundled, and the bundles stamped to identify the quarter-gauge sizes contained therein, and carried in stock by quarter-gauge sizes. Because of the distribution that appeared to be inherent in the process, the price for quarter-gauge sizes was higher than that for a half-gauge or full-gauge size selection.

It appeared to one of our quality men that there was an interesting phenomenon in the delivered distribution from the automatic gauging machine, and so he put his ideas to work. Experiments were conducted for months, and great amounts of data were tabulated. Machine operators co-operated, for they had been sold on the possible benefits to their production and cost records. The result is that today we control the outside diameter within a quarter-gauge size range, and can afford to sell tubing at the price formerly applying to full-gauge size ranges. Clearly, this application has saved money for Corning, not only by a reduction in labor needed for handling, but by a reduction in the number of different sizes to be kept in stock. The price advantage has been passed along to our customers and an important long-range sales advantage has thus been established.

One of our large consumers of radio bulbs, flares, and tubing formerly found it necessary to reject considerable quantities of ware. Rejections were the rule several years ago; not the exception. Process control adaptations and mutually satisfactory acceptance sampling arrangements have, again, been most effective. In the past two years, only one major rejection has been recorded.

In conclusion, we at Corning feel that we have made progress, and while many problems still lie ahead, our experience has already proved the fundamental truth of such familiar expressions as: "Quality is remembered long after price is forgotten"; "Quality cannot be inspected into a product—it must be built in"; "Quality control is 90% common sense and 10% mathematics;" "The proper use of the tool — statistical quality control — can assist in attaining higher production, better quality and less waste"; and "High production and good quality go hand-in-hand."

Having learned something about "The Care and Feeding of a Quality Program," we are prepared to carry it forward and in so doing, to be guided by the same philosophy under which it was introduced, namely, **That the Success of Any Quality Program is Conditional Upon:**

1. Management support.
2. Full cooperation between quality, engineering, and production groups.
3. Quality personnel with enthusiasm, know-how, judgment, imagination, the ability to get along well with people, and minds that are receptive to facts that experience alone can contribute.
4. Thorough planning and cautious execution.
5. Careful preparation of the "formula" and then "slow feeding."

On a Quality Report to Management*

ALONZO C. COHEN, Jr.

ASSOCIATE PROFESSOR OF MATHEMATICS, UNIVERSITY OF GEORGIA

The importance of effective quality reports to management for the successful operation of a quality control program is widely recognized. In dealing with this phase of the subject as Chief of the Quality Control Section at Picatinny Arsenal during the war, the writer advantageously employed reports prepared in the form of summary quality control charts as a medium for keeping management informed about the quality of numerous

*Presented before the Georgia Section, ASQC, October 31, 1947.

products on which the sampling and inspection procedures permitted a ready classification of defectives into categories of "too large" and "too small" respectively.

An example of this type of report, slightly modified from its original form, as used for the weight of certain explosive pellets is given in Figure I. It consists of two component charts constructed with a common time (horizontal) axis and with a common zero point on the percent defective (vertical) axis. The upper chart, employed for recording the percentage of inspected items that are "too large" is in the conventional upright position. The vertical scale of the lower chart on which the percentages of inspected items found to be "too small" are recorded is inverted as shown in the illustration.

The recorded data for each sample consists of the two quantities, "percent too large" and "percent too small." Since items of both categories are defective, the total percentage of defective items is the sum of the two component percentages and corresponds graphically to the length of the vertical bar connecting the two points plotted for each sample.

Thus the chart simultaneously portrays the total percentage of defective items together with a breakdown into the component categories "too large" and "too small" in a manner that permits both a ready analysis of the most recent data as well as a study of the trends exhibited over a long period of time. It reveals at a glance the overall quality picture with respect to the characteristic charted and at the same time discloses whether future improvement in quality will necessitate an increase or a decrease in the target value or a reduction in dispersion.

Charts of the type described were rather extensively used by the writer at Picatinny Arsenal during the war in reporting to management on the height, weight, and density of explosive pellets and charges for various items of ammunition, dimensions of machined parts, and for the time of action of delay elements for several types of delayed-action bomb and artillery fuses. The reports were brought up to date and submitted monthly. Each entry represented the cumulative results of the routine production line sampling inspections performed during the previous month. Results of retests and second samples were excluded from the cumulative samples because of their inherent bias.

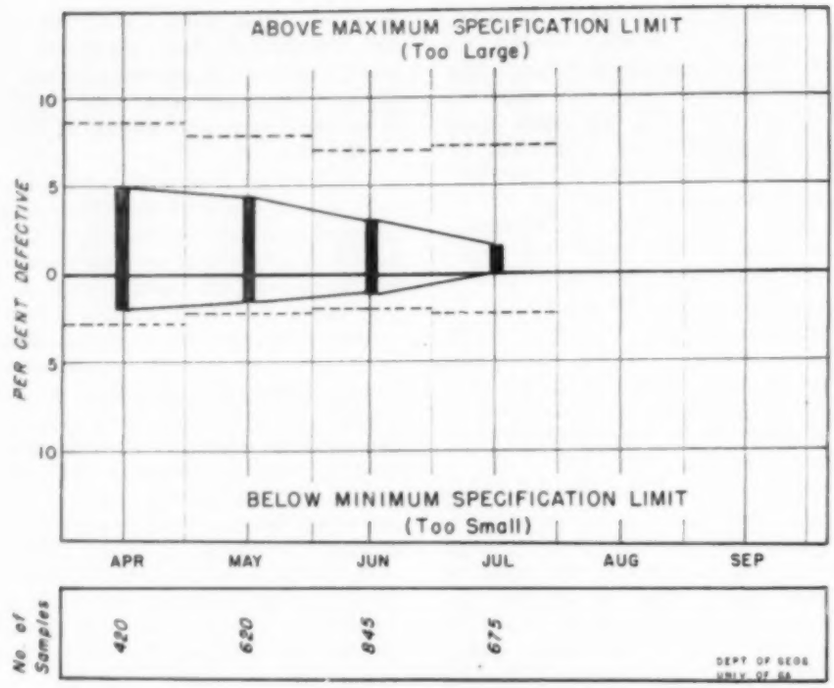

FIGURE I—SUMMARY QUALITY REPORT ON THE WEIGHT OF AN EXPLOSIVE PELLET FOR A DETONATOR

The upper control limits, shown as broken lines in the illustration, are the usual 3σ limits

$$(\sigma = \sqrt{p(1-p)/n})$$

converted to percentages. The lower control limits were omitted since primary managerial emphasis was concerned with reducing high percentages of defectives and the additional lines required would tend to clutter up the chart.

A standard value of p for each of the component percentages was determined over a base period of time during which the quality was considered to be satisfactory. Since the monthly sample sizes were not equal, the width of the control bands varied from month to month as illustrated, and in practice it was found desirable to record the actual monthly sample sizes as supplementary information.

The presence of control limits on charts of this type serves to indicate wether or not overall statistical stability has been achieved from month to month and thereby provides a basis for judging the adequacy of corrective action taken at the source of production when production line charts indicate the presence of assignable causes.

In the author's experience with this type of summary charts, he has observed that if prompt remedial action was taken each time production line control charts sounded their warning of trouble by exhibiting points beyond control limits, then the summary charts seldom exhibited points beyond their control limits. The converse of this statement has likewise been found to be true.

Because of the emphasis placed on actual failures to meet specification requirements, this type of chart also proved quite popular with many management representatives for summarizing results of inspections in which actual measurements were made, although it was originally designed for use in connection with inspections performed on a "go," "no-go" basis.

Chemistry Finds Uses for Quality Control*

EVERETT V. LEWIS

E. I. DUPONT DE NEMOURS AND COMPANY

There is an old saying among journalists that if a dog bites a man that is not news, but if a man bites a dog it is front-page news. Most of us are used to the idea that any plant group to which quality control is proposed will say that it can't be used with their process. We don't consider that news. But recently a chemical process was surveyed by a quality control man who subsequently reported that quality control principles could not be applied to that process. This is striking news. It so happens that the process in question is one with which the writer is quite familiar and which appears to him to be a natural field for the profitable application of quality control principles and procedures.

In looking through some of the recent literature on the application of quality control in the chemical industry, one seems to see two apparently contradictory statements recurring frequently. On the one hand, we read that the statistical techniques used in quality control are directly and quite obviously applicable in the chemical industry. On the other hand, we read of peculiar features of the chemical industry which seem to require special quality control methods. As is so frequently the case, the truth lies between these two extremes, and perhaps a little consideration of the nature of a chemical process will show why this is so and will clarify some of the apparent confusion.

In a typical chemical industry raw materials enter the plant and are combined under certain specified physical conditions to yield a different product which is then shipped out of the plant. Thermodynamic principles tell us that what happens between the receiving and shipping rooms is precisely defined by the concentrations, temperatures, pressures, etc. involved. Practical experience shows variations, often objectionable, in the outgoing product.

At this point quality control becomes useful. One can subject the data on the various properties of the outgoing product to control chart analysis. He will usually find that at least some of these properties are not under statistical control. A simple and logical step will then be to chart the operating data during the course of manufacture of the product. If these charts are prepared with the abscissas so arranged that the process data pertaining to any given point for final product will lie on the same ordinate, it frequently will be found that out-of-control points on the product are associated with out-of-control points in the process. Suitable corrective measures can then be arranged. Such measures may constitute better control of a temperature, pressure, or cycle, or they may constitute more careful adjustment of a concentration. In other cases it may be necessary to scrutinize the operation for off-standard practices, such as, for example, incorrect preparation of filters, or improper setting of flow distribution baffles.

Up to this point, the quality control procedures seem to be quite analogous to those used in the piece-part industries. One merely substitutes in his thinking a temperature, pressure, or concentration for such factors as tool diameter, eccentricity, or cutting speed in the latter industries. The inspection for off-standard procedures is quite comparable and probably equally difficult in either industry.

However, one may quite often find that, do what he will, the product still remains out of control. Here we can take advantage of the underlying thermodynamic principles mentioned earlier. They teach that there are definite numbers of variables and definite relations between them which must control the process. Those variables which are, in fact, controlled or recorded in the actual processing may or may not contribute a major portion of the actual variations. We can then profitably make use of another statistical technique, namely, multiple correlation. If the thermodynamic equation involving the measured process variables is fairly well understood, then one can use the process records and a multiple correlation analysis to evaluate from going data the constants for the thermodynamic equation.

The results of such an analysis may be used in two ways: first, the constants may be compared with those theoretically computed, and, second, the standard error of estimate for the resulting equation may be compared with the standard error of the determinations of final quality. If the constants found are not quite close to the theoretical constants, or if the standard error of estimate is large compared with the precision of measurement, we have to look for other variables which may be affecting our process. Such variables may be impurities in one or more of the chemicals employed, which, by side reactions, affect the product, or they may be impurities which adversely catalyze the main or a side reaction. In other cases, such an analysis may drive home to us the fact that we are not actually controlling all of the controllable variables in the thermodynamic equation. The steps to be taken in such cases should be quite obvious.

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The foregoing procedure is applicable to many of the simpler processes, but there are probably millions of pounds of chemical products made in this country every year by processes for which the detailed thermodynamics have not been evaluated. In such cases the multiple correlation technique may prove an even more valuable tool in reducing the occurrence of out-of-control product. Such an analysis can begin with the assumption that the product quality factor in question is linearly related to each of the measured process variables. As the analysis proceeds one will presently arrive at a multiple correlation co-efficient, whose square measures the fraction of the variation in the product which can be accounted for in terms of variations in the process variables. If this square is not close to unity, two courses of action should be followed. First, the partial correlation coefficient for the product quality with each of the process variables should be evaluated. Where this correlation is low, a plot of the data may show that the correlation is good, but curvilinear, and suitable adjustment in the form of the equation can be made for this condition. Where the lack of correlation is due to a scattering of points for this particular variable, it is possible that the process variable is not precisely measured, and steps may be taken to improve this condition.

Working in this way, then, one can frequently develop an improved understanding of his process, and therefore an improved control. If the demonstrable relations between the product quality and process variables, after the steps just discussed have been completed, still do not account for a sufficiently high percentage of the total variation in the product, the results of the study may suggest other variables to be measured and included, so that finally one will come to the desired degree of understanding of his process.

At any rate, as the study progresses, the going control charts will show whether or not the product is coming increasingly under control, and a point may be reached where the unknown variables are sufficiently random in behavior so that the product gives evidence of control and the limit are entirely satisfactory for commercial processes. This is a very happy condition. On the other hand, one may well find that when the process is under control the limits are still unacceptably wide. In such a situation the multiple correlation analyses, together with the demonstration of control, becomes particularly useful.

With the effect of each of the process factors on product quality known, one is in a position to take intelligent steps toward narrowing the range of variation. Frequently, it will be found that one factor contributes importantly to variations in the product quality, but for one reason or another, it may be economically or technically impractical to narrow the range in this factor. There may, however, be other factors, the individual effect of each of which is small, but of which the total effect is adequate to produce the desired improvement in uniformity, and it may be economically and technically practical to narrow the range of these factors. The step to be taken here is obvious.

As an example of how this sort of thing can work out, we consider the case of a process in which it had been traditional to watch and control one factor very closely at considerable expense. A second factor received little attention, while a third received perhaps normal attention and adjustment. In this particular process, yields were sufficiently erratic to be out of control, and they averaged lower than was desired. The technical background for this process, while good, was not complete and a multiple correlation, such as outlined above, brought out the following facts: first, the expensively controlled factor had little influence on the yield so that variations several times those observed would hardly have registered on the end result. Second, the factor to which little attention was paid proved to have a very important effect on the yield. Third, the last factor actually affected the yield in a direction opposite to that in which it had been believed to operate. You may well ask why this discrepancy had not become obvious since correction had often been made in this last factor. Actually the unobserved variations in the second factor had sufficiently upset the end results so that the discrepancy had been concealed. When the results of this analysis were put to use in the plant, yields were improved and costs were lowered.

This brings us to an important aspect of quality control in any industry which is, as many writers have pointed out, particularly pertinent in the chemical industry. Bad quality cannot be inspected out of a product in any profitable way; quality must be built into it. Therefore, it seems particularly pertinent in the chemical industry to start a program with control charts on the end product and to work back through the process along the lines indicated above, until the places at which the desired end qualities are built in are thoroughly located and understood. Appropriate means should then be taken to see that adequate and proper control is maintained at these points.

When this has been done, the next step, which we too often forget, should be taken, viz, testing and charting of the end product should be reduced to the minimum necessary to obtain an adequate record and proof of quality. When the whole job has been done, quality control charts may, and probably will, no longer be needed at any point in the operation since the limits will be clearly understood. Of course, in many operations the situation may be sufficiently complex so that one will need a sort of in-process gauge of the prior accumulation of uncontrollable factors up to critical points.

The quality control chart proves very effective in arranging special treatment or disposition of partially processed material. The writer knows of one plant which was operating quite an intensive quality control chart program a few years ago. As a result of this program, the operations are now so much better understood that comparatively few charts are needed and used in normal operation. The results of this work, however, sufficiently demonstrated the effectiveness of the technique so that, when trouble is encountered at the plant, control charts are resumed for the operation involved as a means of locating and correcting the source of trouble.

Naval Ordnance Procedure in Classification of Defects

C. C. VAN VECHTEN AND I. B. ALTMAN

NAVY DEPARTMENT, BUREAU OF ORDNANCE

In order to make for uniformity in the evaluation inspection of Naval ordnance material produced by a private contractor or a Naval activity, a formal classification of defects for the particular item is utilized. Instead of relying on each individual inspector to determine the relative importance of a deviation from specification, the technical experts of the Research and Development Division, the Production Division, and the Quality Control Division of the Bureau of Ordnance, after thorough discussion, determine the proper classification of all possible defects that may occur in the manufacture and assembly of the piece.

Defects are classified in the following categories:

(1) **CRITICAL** — Any defect that judgment and experience indicate could by itself, or by its relation to other components, result in a failure or malfunction involving safety of personnel using or maintaining the item, or for major end-products such as a ship, torpedo, or aircraft, failure of the end-product to perform its intended tactical function. For critical defects the maximum possible assurance that the defect is not present is required.

(2) **MAJOR**—Any defect not in the critical classification, that by itself, or by its relation to other components, could result in a significant failure, malfunction, reduction in effective life, or interference with fleet maintenance. For major defects, a high degree of assurance that the defect is not present is required.

(3) **MINOR A**—Any defect not in the critical or major classification, that could by itself, or by its relation to other components, result in a failure or malfunction which would not significantly reduce the effectiveness of the item or related components.

(4) **MINOR B**—Any defect representing a departure from established standards of workmanship, or other similar standards, which has no significant bearing on the effective use or operation of the item, and which does not involve any of the factors listed under Critical, Major, or Minor A.

The usual procedure at the conference called by the Quality Control Division and attended by representatives of the Research and Development and Production Divisions for determination of the approved classification of defects for an ordnance item will be described briefly. The tentative classification of defects prepared by the technical experts of the Quality Control Division are distributed to the representatives of the Research and Development and Production Divisions along with the blue-print drawing of the item under consideration.

The first group to be considered in the tentative classification is the possible critical defects. All the possible considerations and arguments of the effect of deviation from the drawing tolerance of each of the dimensions and characteristics listed will be discussed by the technical experts of the various divisions. After agreement is reached on the possible critical defects, the possible major defects are considered in order. Similarly, the Minor A and Minor B defects are discussed, and shifts made to higher or lower classifications as warranted.

In addition to the considerations as defined above for the various classes of defects, the following statistical technique is utilized in determining the proper classification for a dimensional defect.

(1) Assume a dimension of 2.00" ± .01". In classifying the defect, the question to be answered is as follows: If the dimension either exceeds 2.01" or is less than 1.99", what will be the effect on the assembled unit? In many cases the effect of the out-of-tolerance dimension will depend upon how much the tolerance is exceeded; i.e., if the defective pieces are 2.011", the defective may be a Minor A, but if the defective could be as much as 2.03", it might be Critical.

(2) In order to determine the maximum or minimum deviation from tolerance dimension which can occur for the purpose of classifying the defective dimension, the graph shown in Figure 1 has been developed. By use of this graph, it is possible to determine the maximum or minimum value of a given dimension that can be expected in material which meets the acceptable quality level, the lower limit of good material requirements. The classification consideration can then be limited by these maximum and minimum dimensions.

(3) To use this graph, it is necessary to know the AQL which is to be used for each defect. For a given AQL, read from the graph the appropriate correction factor; i.e., for an AQL of 2%, the correction factor from Figure 1 is 1.39.

(4) The correction factor is multiplied by one-half of total tolerance (T/2) and the result added to nominal dimension (N.D.) to

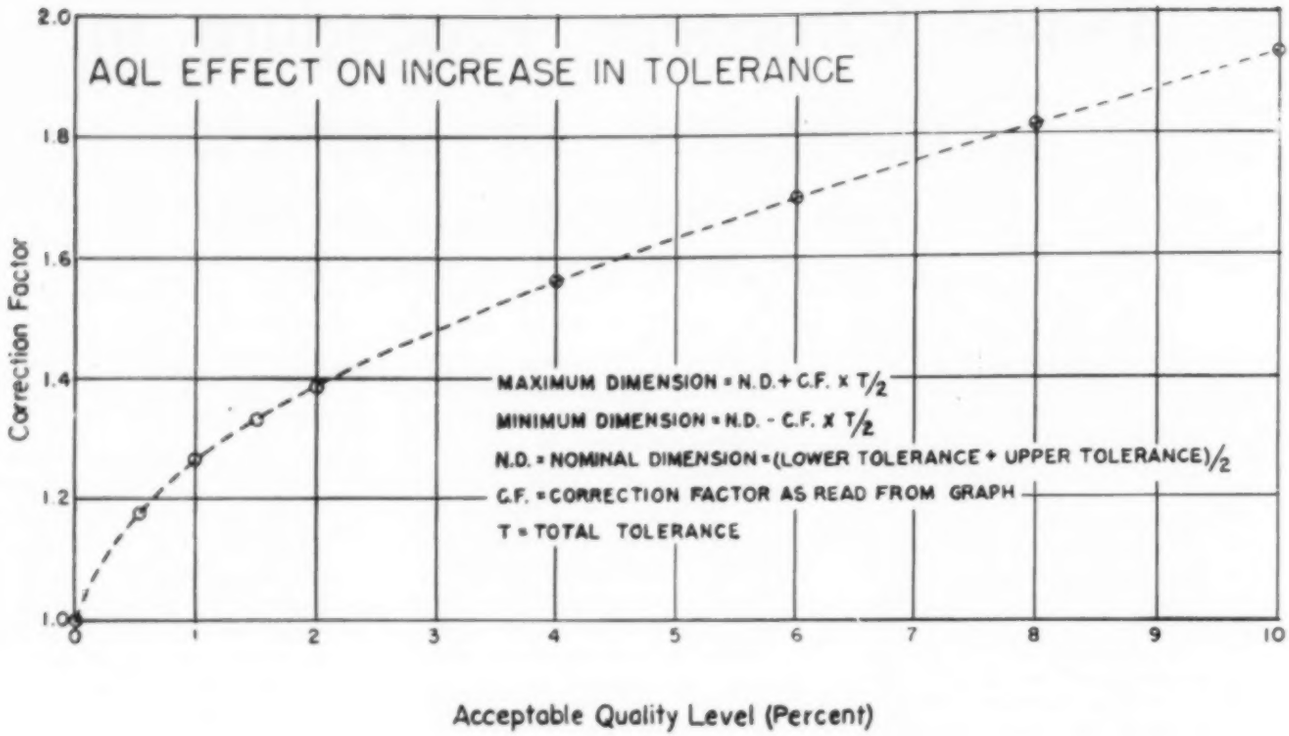

FIGURE 1

give the maximum dimension; i.e.,
(1.39)(.01") = .014"
2.00" + .014" = 2.014".

(5) Similarly, the minimum dimension is
2.00" − .014" = 1.986".

(6) As computed above, the extreme dimensional condition that may be expected in material of 2% AQL, will be 2.014" and 1.986". Now the classification of this defective dimension can be considered on the basis of "What is the effect of an out-of-tolerance dimension which can be as bad as but no worse than 2.014" and 1.986"?"

In the construction of the curve in Figure 1, the circled points were computed as follows.

(a) Assume that a specific dimension of an item produced by a machine operating in statistical control is distributed approximately normally as shown in Figure 2, where

T = total tolerance,
T_L = lower tolerance limit,
T_U = upper tolerance limit,
A_1 = percent produced below lower tolerance limit,
A_2 = percent produced above upper tolerance limit,
X_1 = increase in lower tolerance,
X_2 = increase in upper tolerance.

(b) For an acceptable quality level of 2% defective divided between A_1 and A_2, assume first that $A_1 = 1.00\%$ and $A_2 = 1.00\%$.

Then, from a normal curve area table, we find, at $t = 3$, that the area above $t = 0$ is .4987. When the area is
.4987 − .0100 = .4887,
the value of t is 2.28.

Hence,
(1) $X_2 = 3.00\sigma - 2.28\sigma$
$= 0.72\sigma$.
Similarly, $X_1 = 0.72\sigma$.
But $X_1 + T + X_2 = 6\sigma$, and from (1), $\sigma = X_2/0.72$.

Hence,
$X_1 + T + X_2 = 6X_2/0.72$.
However, in this case, $X_1 = X_2$, so
$2X_2 + T = 6X_2/0.72$,
whence, for $A_1 = A_2 = 1.00\%$,
$X_2 = 0.158T$.

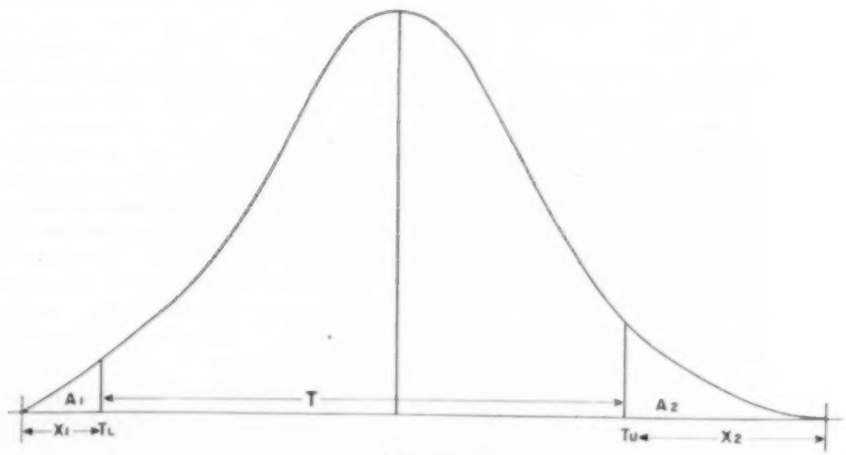

FIGURE 2

The results of similar analysis for other apportionments of A_1 and A_2 are shown in the accompanying table.

A_1	A_2	X_2
0.75%	1.25%	0.175T
0.50%	1.50%	0.186T
0.25%	1.75%	0.194T
0.00%	2.00%	0.193T

Interpolation by the method of finite differences gives a maximum value of 0.195T. Interchanging A_1 and A_2 values yields the same results with X_2 replaced by X_1. Thus, for an AQL of 2% defective divided in any manner between A_1 and A_2 the maximum increase in total tolerance is 19.5%, or an increase in one-half total tolerance of 39%.

Hence, for AQL = 2%, the maximum dimension to be expected is given by

$$(N.D.) + T/2 + X_2 = (N.D.) + T/2 + (.39)(T/2) = (N.D.) + 1.39(T/2),$$

and the minimum dimension is $(N.D.) + 1.39(T/2)$.

(c) For other acceptable quality levels from zero to 10% defective, computations following the above pattern were made. The results are indicated by the circled points in Figure 1.

Purchasing and Quality Control*

STUART F. HEINRITZ

EDITOR OF **PURCHASING** MAGAZINE

According to good scientific procedure, we ought to start with a few definitions in a discussion of this kind, in order that we may have a common premise. Otherwise the points we make upon this chart of correlation between two important industrial functions will deviate far from the normal line and we might end up with a meaningless pattern. At the outset, therefore, let us note three things that are characteristic of the purchasing job in any type of enterprise. Then we can tie in the relationship of purchasing and quality control to these three points.

NATURE OF THE PURCHASING FUNCTION

First, the purchasing agent's position in business organization and operation is unique in that his contacts are always in two directions — internally, with those within his own organization whose needs must be satisfied by the things he purchases, and externally, with the companies from which he procures the products and services required. The nature of these contacts and relationships is not that of a stage in a serial process, like the progress of a piece of material along a production line. The responsibility and the flow of work move in both directions. In the process of procurement, the purchasing agent must interpret his company's need to the supplier, in order that the product purchased may be most suitable to the need. Conversely, he must interpret the supplier's proposal to his colleagues in design, manufacturing, and other departments, again relating it to the need. Frequently he is the means of bringing the two together in person, the supplier and the user. In any case, it is his responsibility to bring about a meeting of minds as to what is acceptable.

Secondly, the purchasing agent is a negotiator. It is common knowledge that the essence of successful dealings with suppliers, and the establishment of sound and satisfactory vendor relationships, on all but the most routine requirements, is a matter of negotiation. A purchase negotiation is not concerned with price alone, nor is the word synonymous with compromise. It is concerned with every detail of the product under consideration and with all the terms and considerations of the transaction; it is the means of bringing about that meeting of the minds for the common good and for mutual satisfaction.

It is equally true, and equally important to remember, that the internal relationships and decisions are also based on negotiation. The word is not commonly used in this connection, but it is nevertheless an accurate description of what takes place whenever two or more viewpoints have to be reconciled, as in the writing of a purchase specification, or in determining the relative weight to be attached to such factors as quality, precision, availability, convenience, assurance of supply, and cost. It is not a question of who shall tell whom what is right, but a question of deciding what is to the best interest of the company in the end result. The answer is rarely so obvious that the process of discussion, or negotiation, can be dispensed with.

Thirdly, it is the purchasing agent's constant responsibility to get maximum value for his company's dollar. Management properly expects this of the purchasing department, and in the long run management rates purchasing performance by this criterion.

Quality is, of course, a factor of value. Purchasing and quality control are on common ground up to this point. But quality alone is not the measure of value. Whereas quality is the prime factor and objective for the engineer, the purchasing agent puts it on one side of the scale and balances it over against the dollar sign of ultimate cost, and sooner or later in this process he runs into the law of

*Presented at the Second Annual Convention and Fourth Annual Rochester Clinic, ASQC, Rochester, N. Y., February 16, 1948.

diminishing returns. Then, if he is a competent and conscientious buyer, an argument begins. If purchasing agents, over the years, have earned a reputation as overzealous advocates on the side of the dollar sign, it may well be because those engaged in other functions or phases of the business have been too little concerned with the practical realities of cost. Management has reason to be grateful when both viewpoints are intelligently and vigorously represented in the company councils.

INTERNAL RELATIONS BETWEEN QUALITY CONTROL AND PURCHASING

These characteristics of purchasing are stressed at the outset because they are fundamental in any consideration of inter-functional relationships. For it follows that in dealing with purchase factors, the quality control engineer must recognize that he has the dual problem of coordinating with his own purchasing department and of contributing to the satisfaction of the customer's purchasing agent; he must be prepared to negotiate the claims of his particular function; and he must know that the ultimate decision will rest upon a determination of value.

Upon these premises, we can proceed to the practical consideration of how quality control and purchasing can best work together.

The science of quality control, in its general application to industrial operations, is relatively new and it has had to find its proper place in the complex industrial organization. It is natural that in this process of adjustment, some frictions developed before the gears meshed smoothly, some toes were stepped on, some cherished prerogatives violated. Purchasing is not quite so new, but it is still one of the younger professions; there are many men in purchasing work today who vividly recall when their own position was going through the same stage. This should make for sympathetic understanding. At the same time, it may explain some sensitivity and the vigorous defense of hard-won prerogatives.

Many of these particular difficulties have been pretty well ironed out by now. As recently as two years ago, a joint meeting of purchasing and quality control men could be relied on to develop a first-rate argument. Such a meeting was pretty certain to produce a spirited discussion and airing of a whole series of controversial incidents — how quality control had switched to a new, and doubtless better, type of acceptance testing, to the confusion of vendors who had conscientiously manufactured to test methods prescribed in the purchase contract; how forty cents' worth of testing was added to the cost of a twenty-cent product; how goods were cavalierly slated for return to a vendor after they had been several months in stores and with no replacements in sight; the extreme case of extraordinarily high rejections of a delicate part that was literally being worn out in the process of acceptance testing. Instances of this sort would be very rare today, for purchasing and quality control understand each other better, and with an understanding of what each is trying to accomplish comes a respect for methods and for the bounds of authority. Still it may be helpful to review briefly the prerogatives that are necessary to do an effective purchasing job, in order that the two functions may work together most harmoniously and effectively.

PREROGATIVES OF PURCHASING

By and large, the purchasing agent has no ambition to be the sole arbiter of what shall be purchased. Purchases are made to meet needs that arise in operating departments. The purchasing agent has a right to expect that these needs, and the minimum quality or properties required to meet them satisfactorily, shall be specifically defined as the basis for his search for a supplier and for evaluating products. He has a right to participate in the formulation of that specification to the extent of being assured that the various alternative possibilities have been given thorough consideration, that the definition does not unnecessarily restrict competition and deprive him of the opportunity of selecting a supply source from among alternative vendors, that it conforms so far as practicable with commercial standards and usual commercial practice in the field concerned, and that allowable tolerances are as liberal as possible for the intended purpose, without sacrifice of necessary quality and without a cost premium for excessive quality factors.

The purchasing agent recognizes the soundness of a policy that separates the responsibility for procurement and for acceptance. It is his part of the job to find a supplier who can and will meet the quality requirements, whose delivered products will be "up to print". But in fairness to both the vendor and the buyer, the quality standards by which such performance is to be measured should be clearly understood and not subject to change without notice, for they are an integral part of the negotiation and the contract.

The purchasing job requires time for efficient performance. This applies not only to procurement time, or lead time, in these days of slow deliveries. Time is needed for exploration of the market, for research studies of sources and facilities, and of substitutions that may be necessary or desirable, for developing competition, and for negotiation. Furthermore, the time element is customarily involved in term contracts and forward commitments. Consequently, when any change in quality factors is contemplated, the purchasing agent has a right to expect that he will be consulted and given the opportunity to complete or adjust outstanding orders and to balance out current stocks.

PURCHASING MUST DEAL WITH VENDORS

Most important of all — and this is a prerogative that the purchasing agent will defend to the utmost, whether dealing with quality control or any other functional department — he will insist that all dealings with vendors be carried on through the purchasing department. This principle is pretty well established in respect to the actual buying operation; it is equally important in respect to subsequent contacts. The reason for this insistence is simple, and it is basic. Good vendor relations are the most valuable asset that any purchasing department can have; no purchasing program is stronger than its vendors and their loyal cooper-

ation. These relationships are carefully cultivated over long periods of time. Properly nurtured, they are sturdy enough to carry a company along through the most difficult times. Yet withal, being a product of personality and human relations, they have rather a delicate constitution and can be easily blasted by impersonal or inconsiderate treatment. An arbitrary notice of rejection, or even the receipt of correspondence from someone not known to the vendor, who has not figured in previous negotiations, can do untold damage to such a relationship and give a serious setback to a company's service of supply.

Therefore, if materials are deficient from the standpoint of quality control, the proper procedure is to report the deficiency to the purchasing department, and only through that department to the vendor. In making this suggestion, purchasing does not ask quality control for one moment to compromise or to relax its quality standards. Rather, look at is this way: if the purchased material or product is unsatisfactory, it is the purchasing department that has failed to meet its obligation, either by selecting the wrong vendor or infailing to make the requirement clear or holding the vendor up to the necessary standards of performance. The purchasing department cannot evade these responsibilities.

If the vendor is at fault, there is no one in the entire organization in a more favorable position to secure corrective action than the buyer who is familiar with the entire background of the transaction, knows the extenuating circumstances, if any, has the personal contacts with the responsible persons in the vendor company, and wields the potent leverage of future business dependent on good will and satisfaction. Time and again it has been proved that, for these selfsame reasons, the buyer is the most effective expediter, and best able to arrange for credit or for emergency service. Moreover, the buyer is keenly interested in knowing about the fault and having it corrected, for in the constant effort to build up a reliable corps of suppliers, excuses do not take the place of reliable deliveries, and experience is the best guide in the placing of future orders.

The development of a satisfactory source of supply is frequently a process of education. Errors, however deplorable the individual instance may be in itself, can be a most effective means of education, contributing to lasting improvement and satisfaction. Unless it is a case of a flagrant carelessness or incompetence, there is little to be gained and a great deal to be lost by discarding all that has gone before and starting from scratch to educate a new supplier. And the process of education can work both ways. There are plenty of instances on record where the supplier, called to account for a faulty delivery, has been able to show that the basic fault lay in what he was asked to do — that the wrong material was being specified for a given purpose, or that a part specified as a stamping ought to be made on a screw machine, or **vice versa.** Purchasing agents are practically unanimous in their testimony that friendly suppliers and salesmen are among the most potent sources of valuable information and aid. Even engineers and quality technicians are not beyond the possibility of acquiring similar helpful information from the same sources. Suppliers and their salesmen do not develop friendliness and the spirit of cooperation through arbitrary dealings.

The third practical reason why rejections should be handled only through the purchasing department is that there are several alternate ways of making an adjustment for deliveries that fall short of specified quality standards, other than returning the goods to the vendor. One of these has already been suggested, in that the supplier himself may counsel on the proper application and handling of his product so as to render its performance satisfactory. Another is the diversion of such goods to other purposes for which they may be thoroughly suited; the purchasing agent is aware of the various needs throughout the organization where this might be the case, whereas quality inspection is primarily concerned with the single, specific purpose. Bear in mind that these suggestions are not offered by way of condoning lapses in quality or to justify any lowering of standards; they are merely the practical means of making the best of an unfortunate situation. It is obvious that persistent recurrence of such errors means that a supplier is an unsatisfactory source, and outright rejection is then indicated.

The alternative in which we are particularly concerned here, and which will doubtless be repugnant, at first glance, to the quality control engineer, is an adjustment in price which will fairly reflect the lower value of the lower quality to the buyer's company. If such an adjustment can be made, it may frequently be expedient to do so in these days when replacements are difficult to obtain and long delays may be encountered. Basically, the principle involved is the same as in setting the original specification — to get usable quality representing a fair value for the expenditure; in this case, the principle is applied after the fact of purchase instead of before the fact. It goes without saying that the election of this alternative is not a purchasing prerogative. It is, however, a possibility that cannot be overlooked. It is a matter that calls for negotiation, first with those having the responsibility for quality within the company, and only then negotiation with the vendor. Functional specialization does not set one department of a company against another; it is the means of assuring that all pertinent viewpoints shall receive full consideration as they work together for the best interests of the company as a whole, toward the ultimate objective of value. To this end, all departments — whether concerned with the science of quality, or the science of production, or the science of procurement — must be willing to negotiate to arrive at the most favorable overall solution.

EXTERNAL RELATIONS OF QUALITY CONTROL TO THE PURCHASING FUNCTION

So far, we have discussed only the internal phase of our subject. This is the simpler phase of the quality control-purchasing relationship, for it is worked out in terms of personal contacts within the company organization, with a com-

mon interest in the end product and within the pattern of a common company policy; and there is always top management to reconcile divergent viewpoints and make the governing decisions in the event of any controversial issue.

The external relationship of quality control to the purchasing policy and practice of the customer's company is equally important as it affects product acceptance and sales, and is one of the major factors that will, in the long run, have considerable influence in justifying or failing to justify the policy and practice of quality control. In examining this external relationship, we venture into pioneering ground, for relatively little thought and effort have been expended on this phase.

Again let us start by establishing the points of common agreement. Quality control adds to the value of a product in the way of greater uniformity, fewer rejects, better manufacturing controls and dependable inspection. The person to be convinced of this, beyond your own management, is the customer's purchasing agent, for in line with the responsibilities and prerogatives outlined in the preceding section, he is the primary buying contact with your company's sales organization. He is receptive to the quality control story, at least to the extent that he is willing to concede that, all other things being equal, the manufacturer who practices quality control is a preferred source of supply for the reasons just cited.

But how strong is his conviction on this point? Is it strong enough to result in buying action? How much does he know about what quality control has accomplished in respect to your product? How much does he know about quality control? The rub comes in that little qualifying clause, "all other things being equal". He knows from experience that all the conditions surrounding a purchase are seldom, if ever, equal. You may argue with excellent justification and to good effect, that the application of quality control techniques actually creates a state of inequality, with all the advantage on the side of your product.

Granting all of your claims as to quality as an independent factor, the buyer at this point begins to match it up with other factors, thinking in terms of purchase values. He sees an additional department involved in your production, representing an added cost — a non-productive cost, just as in the case of his own necessary function of procurement, and he may fail to see a similar necessity. Of course that is not an unanswerable argument. I am confident that you could demonstrate that a well conceived and applied program of quality control eliminates costly waste and increases efficiency, just as sound purchasing, which is largely concerned with outright expenditures, can demonstrate important cost economies. And there are plenty of pertinent parallels to be adduced from other industrial functions. In the days of renegotiation, it was a moot question whether advertising expense was a legitimate factor of cost, and that same question has frequently arisen in every buyer's thinking. The answer to that question was in the affirmative. Advertising leads to mass acceptance and supports mass production, with consequent economies in both manufacturing and distribution. Despite the natural question, it is common knowledge that in the industrial field, as in the consumer field, the advertised product has the greatest acceptance. Quality control deals in more tangible factors, to comparable effect.

However, the purchasing agent must be convinced on this point. Ideally, we would like to be able to say that the alert purchasing man will eagerly delve into this matter of quality control, make a broad and searching analysis of its values, convince himself, and beat a path to your door. But we must be practical. The burden of proof is upon the supplier. The most successful vendors are those who maintain an adequate staff of well qualified sales representatives; and as we go into a more highly competitive period of business, both the number and the calibre of sales representatives are on the upgrade. There is an important lesson in this for the field of quality control, and one of the effective instrumentalities for putting that lesson into effect is at hand in the advertising and sales representation of your respective companies, carrying the message to the buyer.

HOW QUALITY CONTROL CAN HELP

First of all, let the purchasing agent know what you are doing in the way of quality control, and what you are accomplishing by this means. Most purchasing agents make it a point to rate suppliers according to their facilities, their financial stability, the character of their management and supervision, their progressiveness as evidenced by research activities and other indicators, all of which stand behind a company's product and service. So far as time and personnel permit, purchasing agents visit the plants of current and prospective suppliers to evaluate these factors at first hand. Surely an effective policy of quality control is one of the factors that should be brought to his attention most forcibly, not only in its contribution to quality of product, but as one of the marks of progressive management and operation.

Secondly, if the purchasing agent is not personally familiar with modern methods of quality control, through experience in his own organization, it will pay to take the trouble of explaining in detail what your objectives are and how you arrive at them. If you are a serious competitor for his business, you will find him interested, and you will also find him quite capable of assimilating the information. A substantial majority of purchasing agents today, particularly among those who have entered the field during the past fifteen years, have a background of technical training and production experience; such qualifications are considered a necessary prerequisite for top purchasing positions in the present state of purchasing science. They are quite competent to read your charts and graphs, but an explanation by an expert in your field would be most helpful in assuring that they will grasp the full significance of the record as it shows the values that are of primary importance in a purchasing decision.

Third, it will be helpful to furnish actual quality control records to

your customer with shipments of the products to which they pertain. This is the added certification to the user of the quality that he is obtaining as a result of your skill and effort, a constant reminder of the special values inherent in your product, a guide to what may be expected in its application and use. This practice has already been adopted by some manufacturers, with good results. And there is precedent for such cooperation in other fields where quality is a determining factor of the purchase. For a number of years, one prominent and successful steel supplier has furnished not only the detailed analysis of each individual heat of alloy steel from which shipments are made, but an individual statement of its heat treating qualities as a guide to proper handling for greatest satisfaction in use. This extra service adds materially to the value of the product to the user. Even more, it strengthens the relationship between the user and supplier. Both of these desirable objectives can be attained by similarly sharing your detailed quality control information.

Fourth — and this point is basic in all of the preceding suggestions — you can enhance the merchandising value of quality control by putting yourself in the customer's place and evaluating your contribution to the overall industrial process, not only in terms of absolute quality or precision as ends in themselves, but in terms of ultimate utility and cost to the buyer. For this is fundamentally the justification of your function; it is what you have to sell.

It is a fine thing for all of us to believe in the particular job we are doing, and to be enthusiastic about it. But sometimes this very enthusiasm is likely to give us a distorted perspective. The real test comes in the acceptance of these values by those whom we serve, whether in purchasing or quality control or any other function, and this acceptance may be the more accurate measure of worth. As your product goes out upon the market, there will be many cases where quality control might easily be oversold, since in the broad range of industry and industrial products there are many instances in which precision and uniformity are of secondary importance, and where the cost of elaborate control methods represents purchasing waste. At the same time — and this is where your greatest opportunity lies — there are many cases in which the utmost progress you can make in this direction is worth many times the effort and the cost involved. Quality always commands a premium, and wherever that premium is economically justified, the producer who consistently maintains quality standards is the leader in his field, the preferred supplier for users of that product.

CONCLUSION

The suggestions made in this discussion have purposely been kept on the prosaic level of everyday operations. In conclusion, they should be correlated so as to fit into the larger picture of functional objectives. They present only one phase of a responsibility that must be viewed from many angles. The quality control engineer has many relationships to consider, with a variety of other functions within and beyond his own company organization, to fulfill his function most effectively. So far as purchasing is concerned, the responsibility of this relationship with quality control is to work together for an integrated policy and program that will provide the plant with adequate materials and parts, that will utilize them most efficiently, and that will offer maximum satisfaction and value to the customer. Each company's end product becomes the purchase component or raw material of the succeeding owner. The industrial ideal toward which we should set our sights views this progression as a continuous, integrated process, from raw material to ultimate consumer, with the appropriate quality and value as factors to be considered at each successive stage. In the complex organization and functional specialization of modern industry, there is no more potent means of achieving this dual objective than through mutual understanding and cooperation in the relationship of purchasing and quality control.

Syracuse Quality Control Project

REPORT OF AN INDUSTRIAL INVESTIGATION AND TRAINING PROJECT IN STATISTICAL QUALITY CONTROL

EDWARD A. REYNOLDS

RESEARCH ASSOCIATE, SYRACUSE UNIVERSITY

In 1946, Syracuse University received a mimeographed announcement from the United States Department of Commerce advising that the Department's Office of Technical Service was considering sponsorship of research projects which might prove of value to industry and requesting the University's advice on projects which it and local industry would recommend. Brig. General Washington Platt, head of the University's Department of Administrative Engineering, arranged several meetings

with technical representatives of local industries and sent the Department of Commerce a list of ten projects recommended by these men. Included in this list was industrial research in statistical quality control. The Commerce Department expressed interest in this project and requested detailed recommendations. These were briefly formulated by the University and the local chapter of the American Society for Quality Control and, following numerous discussions, the Department of Commerce appropriated $19,600 for a one year industrial research and training program in statistical quality control. This was started August 1, 1947 and active work ended July 1, 1948.

A formal report of the work done, results, and recommendations has been prepared and is being forwarded to interested industrial and educational leaders. However, some of this information may be of interest to members of ASQC, and highlights are therefore summarized below. Those interested in details of the project should request a copy of the project report from either the University or from the Department of Commerce.

PRELIMINARY PLANNING

The primary purpose of this program was to determine industrial interest in, and use of, statistical quality control, possibilities for increased use, and the benefits which might accrue to industry through training in these methods. Thus the project work was divided into four main classifications:

1. Survey of present and possible uses and industrial opinion.
2. Training of industrial employees.
3. Evaluation of project benefits to industry.
4. Reporting of results.

A detailed outline covering the proposed work was first drawn up and reviewed with representatives of local industry and the Syracuse Section of ASQC. This was then forwarded to a number of nationally known leaders in the field of industrial quality control for the benefit of their advice. Throughout the project, Syracuse University had the active encouragement of many of these men as well as the complete cooperation of the Syracuse Section of ASQC.

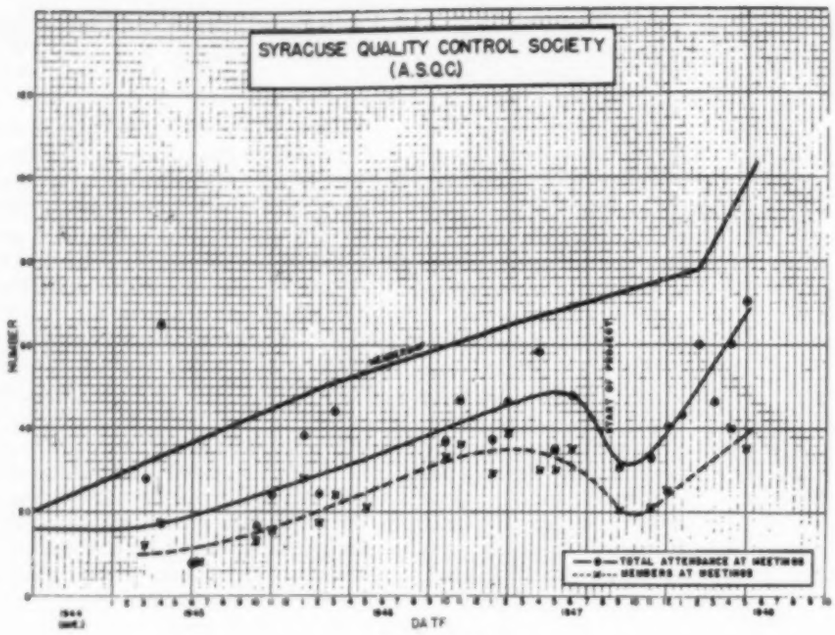

FIGURE 1

INDUSTRIAL USE AND OPINION OF STATISTICAL QUALITY CONTROL

Statistical quality control was not new to Syracuse industry, since, in 1944, an ESMWT course conducted at Syracuse University had been attended by 18 employees from 12 Syracuse manufacturers. Also, in 1946, the Rochester Institute of Technology had conducted a course in Syracuse for chemical industries, and this had been attended by 11 employees of two additional companies. Thus men from at least 14 local companies had been trained and, in addition, there had been an active Quality Control Society (later one of the founding chapters of ASQC) since 1944. The activities of the local Section, as reflected by total membership and attendance at monthly meetings, are shown in Figure 1, which indicates a healthy increase in local interest. At the start of the project the Section had 45 members from 11 local companies, 14 members from 9 companies outside Onondaga County in which Syracuse is situated, and 6 members from non-industrial groups.

Despite this activity in statistical quality control for the past four years, it was found that only a few industries in Syracuse were actually using any portion of these techniques and that most industrial heads and inspection managers were completely unfamiliar with statistical control methods.

In the Syracuse area (Onondaga County) there are 396 manufacturers. Of these, only one was using statistical methods for actual control of production. This one company had two competent statisticians on its staff, as well as other partially trained personnel. It was using control charts very successfully for process control and also more advanced techniques for the evaluation of products, materials, and methods. In addition to this one company with rather full use of statistical control, there were three companies using some form of statistical sampling for attribute inspection (two of them on only a limited basis), one company successfully using machine control charts with specification rather than statistical limits, one using percent defective charts with little or no use of statistical limits, and one company giving extensive consideration to the use of statistical control but still in an experimental rather than an actual use stage. Other than these seven companies, no actual use of statistical quality control could be located in Onondaga County.

Discussions with general managers and quality heads of many companies indicated that over

three-fourths of the men in small companies had never heard of statistical quality control. In the larger organizations, about one-third had never heard of it, about one-third had heard of it and were quite sure that it was useless in their type of production, and about one-third had heard of it and had some degree of interest in its possibilities. Of those who had at least heard of statistical quality control, the most common belief was that it concerned only the replacement of 100% sorting by "10% sampling." This misconception was undoubtedly due to the use of statistical sampling by the Army and Navy inspection services in some of these plants during the war, and the confusion of this phase of statistical control with the common idea of a 10% sample used (at least in theory) in many plants. Regardless of cause, it was very apparent that sampling had received more publicity than other forms of statistical control, despite the fact that most of the emphasis in ESMWT courses was on control charts.

Other than the idea that statistical control was sampling, and therefore could not be used because no defects could be tolerated in their outgoing product, the two most frequent objections to use of statistical methods were: (1) they could not use these techniques because they had no records, and (2) they did not need them because they had no appreciable inspection costs or rejects. The first of these was found to be quite true; the second was usually believed to be in error after a brief inspection of their operations. In a number of large and medium-size companies such costs were concealed by production operators doing appreciable inspection work (including sorting), by keeping no records of scrap, and by considering repair, reclaim, sale of seconds, and selective assembly operations as normal to the process.

Despite the major non-interest in statistical quality control, there were in Syracuse some companies deeply interested in the University program. All of the seven manufacturers using these methods in any degree, and five other companies not familiar with the methods, were at once desirous of having personnel trained, and so advised as soon as the project had been explained to them. To interest others required a considerable sales job.

DINNER MEETING TO INTEREST INDUSTRIAL MANAGEMENT

The original planning of the project included preparations for a management dinner meeting to open the project, and work on this was increased when it was found that only a few companies were interested in the project. This meeting was planned both to interest company management in having personnel trained and also to give these industrial executives and supervisors basic information on statistical quality control — what it was, how it worked, and what advantages it possessed. Top speakers were secured, including the Chancellor of Syracuse University, the President of one of Syracuse's largest manufacturing concerns, the Executive Secretary of ASQC, the Quality Director of a well known national corporation, and the former Editor of **Industrial Quality Control.** In addition, the program included the Johns-Manville training film "Modern Quality Control", which had not been shown previously in this area.

The attendance of 300 persons at this dinner meeting was in excess of original expectations and was the result of hard work on the part of both the University and the Syracuse Section. The president of every Syracuse company with over 200 employees, as well as many of the smaller ones, received an invitation from the Dean of the University Engineering College; all local ASQC members, past guests, and local inspection heads received invitations from the Chairman of the Quality Control Society; and invitations were also sent to local technical associations, manufacturer's association, labor unions, and nearby industries and colleges outside Syracuse. A total of 500 invitation letters were sent out, and each was accompanied by an attractive printed program listing the speakers and describing the purpose of the meeting. In addition, good local newspaper publicity was secured, and the invitations were followed a few days before the meeting by telephone calls to the heads of major companies who had not yet made reservations.

Of the attendance of 300, the position of about half was known. Approximately 15% of the audience held top administrative positions in industry, 35% were inspection or quality supervisors, 20% production supervisors, and the remaining 30% were divided between research, personnel supervision, teaching, sales, etc.

Advance reservations were received from 51 manufacturers, of whom 37 were located in Syracuse. Based on this, known representation from local industry was as follows:

Size of Company (No. of Employees)	% Represented
Over 1000	67%
500 — 999	57%
200 — 499	39%
50 — 199	7%
Under 50	3%

It is believed actual attendance was about 120% of the advance reservations.

Immediately after the meeting a questionnaire was sent to a representative group of those attending, and this, as well as comments expresed by others, indicated that practically all of the attendants found the meeting valuable and interesting. However, approximately 20% stated they would have preferred more technical details and less "selling." These comments also showed that the Johns-Manville film was the most interesting portion of the program to the majority of the audience.

INDUSTRIAL TRAINING CLASSES

At the management meeting, the University's plans for elementary training classes in Statistical Quality Control had been announced and attendance solicited from industry. The original plans called for three such classes for general attendance, each meeting for 2½ hours once a week for 18 weeks; one held mornings, another afternoons, and a third in the evening. However, due to industrial demand, four such classes were arranged. Two in-plant classes were also arranged for two large companies who had a number of employees whom they wished to have trained. A total of 140 employees from 26 companies enrolled, and of these, 103 completed

the 18 weeks of training. About half of those who dropped out did so for personal reasons of sickness, change of job, or increased regular work or travel. The other half dropped out because they either could not comprehend the work or found it of little interest.

The course covered reporting and summarizing of data, simple graphs, frequency distributions, standard deviation, control charts, simple statistical sampling, and an introduction to correlation and tests of significance. The majority of time and emphasis was devoted to control charts and sampling. Each session included class participation demonstrations and problems. Homework was given each week, for which the class members had to apply the methods to actual plant data and problems. Examinations were also given several times during the course. All class problems, homework, and examinations were reviewed, graded, and discussed with the class members, and they were encouraged to secure individual help with their particular problems of quality control. A number of class members were visited at their plants to review these problems.

For text, these elementary classes worked largely with printed notes developed by the writer. In addition, the American Standards Association bulletin Z1.3 on control charts and Dr. Working's paper on the Poisson distribution were used. Other than a $5 fee for notes, books, and other supplies, there was no charge for this training. Over half of the class members attended during working hours, and their $5 book fee was paid by their companies.

For comparison purposes, this same training was given to 90 under-graduate Administrative Engineers in Syracuse University (mostly juniors, with some seniors and graduate students), who were at the same time taking a one-semester course in industrial statistics. These students also prepared term papers by working for 25 to 40 hours in some local plant, getting and analyzing data on an actual quality problem. In this way, the students secured industrial experience in quality control and their work served to interest a number of companies in statistical quality control. To date at least two local companies, not previously using these methods, have hired such students as Quality Control Engineers.

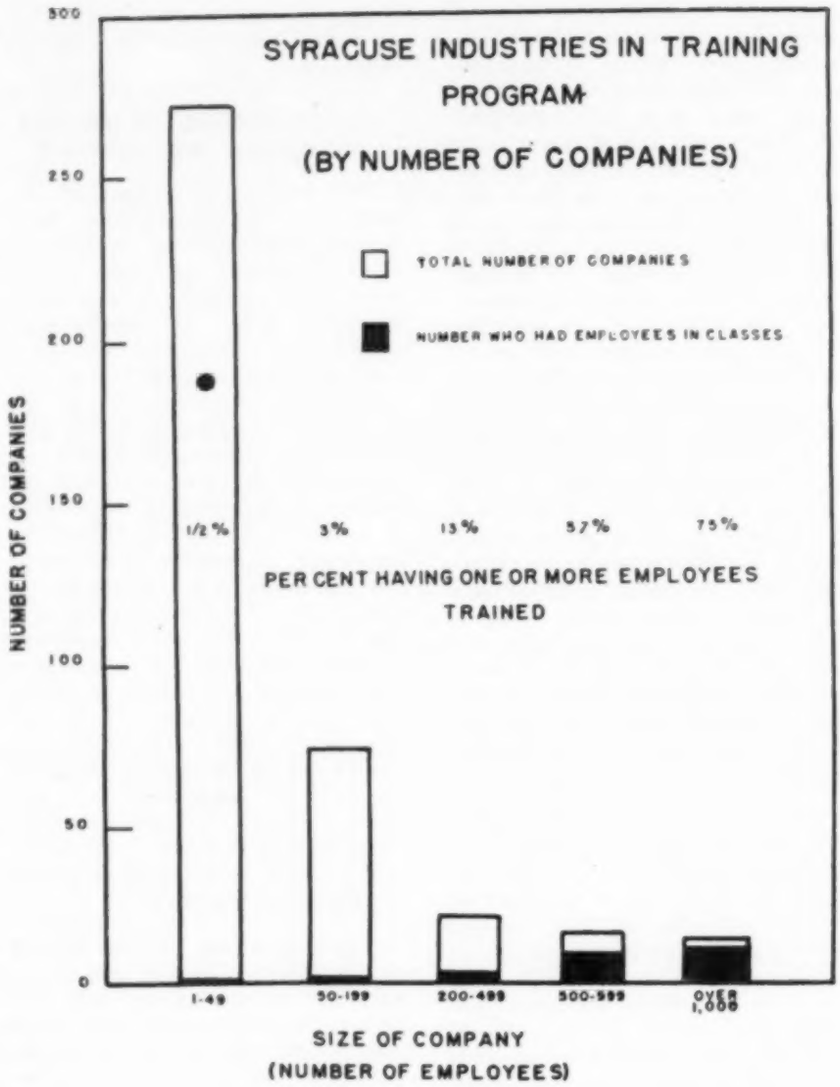

FIGURE 2

It was originally planned that the six part-time classes in elementary statistical control methods would constitute all of the industrial training portion of the project. However, following completion of these, there was demand for advanced training, and Dr. Martin Brumbaugh therefore agreed to conduct an advanced class under University sponsorship. This met for two hours one evening a week, for 11 weeks, and covered tests of significance, analysis of variance, correlation, and sequential sampling. Dr. Brumbaugh used Brownlee's **Industrial Experimentation** as text and supplemented this with homework problems taken largely from mechanical industries. Of the 40 who enrolled for this course, 34 completed it.

A one-week, full time elementary course was also conducted near the end of the project in response to industrial requests, and to secure a comparison between full time and part time industrial training. The subject matter and examinations were identical with the 18 week courses, except that the Dodge and Romig sampling tables were substituted for Dr. Working's paper. This course ran for seven hours per day, for 5½ consecutive days, plus three informal evening sessions. It was

attended by 25 employees from 12 companies, and all completed the course.

To summarize the industrial training portion of the project: 175 persons, representing 22 Onondaga County and 10 other manufacturers and 3 non-manufacturing groups, were given some training. Of these, 127 completed elementary training and 108 were considered competent to use statistical methods and were given University certificates to that effect. In addition, 34 persons, representing 10 Onondaga County manufacturers, 2 outside manufacturers, and 2 other groups, satisfactorily completed advanced training. It is estimated that one out of approximately every 400 industrial employees in Onondaga County had some formal training in statistical quality control under this project and 60% of local companies with over 500 employees have at least one trained person in their organization competent to apply such techniques as frequency distributions, control charts, and simple sampling.

It is believed that some information was secured from this training program which may be of interest and possible benefit to colleges, American Society Sections, and industries contemplating such instruction for industrial employees. This information is therefore summarized below:

1. The major interest in such training was from companies with at least 500 employees. There were many indications that smaller organizations could profitably use statistical controls; however, few of them had personnel suitable and available for such training. Figure 2 shows the proportion of employees trained by size of company. It indicates very limited interest from smaller companies.

2. Examination grades, and discussions with class members, showed that college graduates assimilated this training much more readily than employees without college education. The non-college employees had difficulty not only with simple algebra and square root, but also equal difficulty with arithmetic. In addition, they were slower to understand basic concepts. This difference between college and non-college employees was more pronounced at the beginning of training than at the end of the courses, indicating it was primarily due to prior education, rather than to any real difference in intelligence or learning ability between the two groups. There was no apparent difference between engineering students and industrial employees who were college graduates with regard to marks obtained or ease of learning.

Final Examination Marks of Various Classes

Industrial employees broken down by college graduates and non-college graduates in comparison with engineering students.

	General Classes		In-Plant Class #1		In-Plant Class #2		One-Week Class		
	College	Not College	College	Not College	College	Not College	College	Not College	Engineering Students
90 - 100	𝍸 ////	𝍸	///		///	//	//	/	////
80 - 89	𝍸 //	𝍸 ////	/	////	/	///	///	////	𝍸 //
70 - 79	𝍸 ////	𝍸 //		//	///	///		///	𝍸 𝍸
60 - 69	////	///			/	///	//	//	𝍸
50 - 59	/	//	/	////		/		///	////
40 - 49		//			/			///	/
30 - 39		//				//			
20 - 29								/	
Average:	81.7%	72.7%	84.8%	70.2%	78.8%	69.4%	83.6%	65.1%	73.5%

FIGURE 3

3. In addition to prior education, it was apparent that older industrial employees had slightly more difficulty with this training than younger men. The average final examination mark for employees 20-30 years of age was 79%, as compared with an average of 72% for employees 40-50 years old. However, the effect of age was much less than the effect of education and, while significant, the correlation between age and mark was only —.33.

4. There was no apparent difference, in either interest or ability to understand, between the full-time one-week class and the part-time 18-week classes. The final examination marks for the one-week class were slightly, though not significantly, lower; however, the poorest students dropped out of the 18-week classes, whereas all in the one-week class completed the course and took the final examination. It appeared that the part-time class advantage of homework and application of the methods as training progressed was balanced by the full-time concentration of the one-week class. Incidently, there appeared to be no difference between the two types of classes with respect to prior education, age, or industrial position of the class members.

5. There was no apparent advantage of in-plant classes over general classes, even when the in-plant class was co-conducted by a company employee and worked largely with company problems and data. Figure 3 shows the distribution of final examination marks for in-plant classes in comparison with general classes.

OPPORTUNITIES FOR INCREASED USE OF STATISTICAL CONTROL

Both prior to and during the industrial training portion of the project, visits were made to local plants, and quality problems and quality control methods were discussed with general managers and quality supervisors (where such a position existed). In all, 50 manufacturing plants were visited, and in 34 of these the actual operations were inspected by spending from one to eight hours in the plant. These companies produced almost every type of product — drugs, home appliances, industrial machinery, food, castings, paint, paper, boxes, shoes, caskets, candles, knives, radios, dishes, clothing, needles, etc. They varied in size from 10 to 5000 employees. Some of them were mass producing many of the same item; others made only one of a kind.

At least two-thirds of those inspected had important quality problems, although in several cases management was either unaware of them or reluctant to admit them. Almost without exception, both management and quality supervision of plants not using statistical control blamed their quality problems, not on poor control, but on poor materials, poor machines, or poor workmen. Obviously the first step toward improvement is to admit the possibility of improvement, and management reluctance to consider that a better job might be done with existing machines, materials, and personnel is one of the greatest obstacles to increased use of statistical quality control.

Of the 34 plants actually inspected, it was the writer's opinion that the use of elementary methods of statistical control would have produced worthwhile improvements in 11 of these within a few months. These were the companies with generally poor quality supervision and with apparent high scrap and inspection costs (in general, these were also the companies where management had no records of quality costs and little interest in possibilities of improved control). In addition, 13 of the plants inspected had more complex quality problems which would take much longer to isolate and correct. In all of these, however, it was the writer's belief that a combination of good engineering and good statistical control knowledge would permit solution with very important savings.

In the remaining 10 companies inspected, there were no indications of excessive quality costs and, based upon management's opinion that product quality was all that was desired, there appeared no need to consider improved methods.

There was no indication that size or type of product affected possibilities for the use of statistical quality control, except that the very small manufacturers would undoubtedly have difficulty in finding someone in their organization with sufficient education and sufficient time to install these methods, and probably they could not afford the full-time services of a quality control engineer. It is unfortunate that quality control consultants do not feel they can afford the effort to interest small companies, for these are the ones that could most logically benefit from such services.

EVALUATION OF PROJECT BENEFITS TO INDUSTRY

Inasmuch as this report is being written only a few months after completion of the first group of training classes, and only a few weeks after completion of the last, it is extremely difficult to assay the benefits to industry with any accuracy. Arrangements have been made with the Administrative Engineering Department of Syracuse University to investigate industrial results after another year has passed. Those interested in a copy of such a follow-up report should so advise the University. However, the preliminary opinions of both class members and industrial management can be reported now.

At the conclusion of elementary training classes, each industrial student filled out a questionnaire covering his comments on the training and on statistical control and returned it unsigned. One of the questions asked was whether he had obtained "great benefit," "some benefit," or "practically no benefit" from this training. Fifty-four percent stated they believed it had been of great benefit to them: 45% reported some benefit; 1% replied "practically no benefit." Other questions asked if they would recommend that others in their company take this training, and if they themselves would like additional training in statistical control. Ninety-four percent recommended that others in their companies receive basic training; 88% desired additional training. Of the part-time elementary class members, 71% stated they had already applied the methods to actual quality problems, and, of these, 51% reported it had already been of benefit, and 48% stated that they expected it would prove of benefit in the future.

The general managers or presidents of the 22 Syracuse companies having employees trained were contacted at the end of the project: 2 stated that the project had been of definite benefit to them, 9 stated that they thought it had been valuable but they could not point to any definite improvement or saving, 6 stated that they did not believe these methods suitable for their processes or problems, and 5 did not reply to the University's letters. Only one of these companies was willing to underwrite continuation of the project by contributing $500 toward the cost of training classes for the coming year.

RECOMMENDATIONS

Detailed recommendations to industry and education, based on this program, are contained in the formal project report. In addition, there is much the American Society can do to aid industry by furtherance of improved quality control methods. Among these are the development of special aids for the small manufacturer, liaison with education to provide adequate undergraduate and extension training in statistical control, and establishment and enforcement of standards of Society membership so that prospective employers can use membership as a criterion of competence. All of these have been discussed before and some of them are presumably in effect, or expected to be at some future date. The writer will, therefore, confine his recommendations to only one general thought for the Society.

The American Society for Quality Control is the logical group to give industry non-mathematical, interesting, and convincing explanations of statistical quality control, so that management and supervision know what it is, how and why it works, and what it can and cannot do. To date the Society has not succeeded in doing this one most important job. It is a big job and it will take a long time, but it will never be done by having meetings attended mainly by quality control engineers, and by publishing articles read exclusively by semi-statisticians.

It is recommended that the Society develop a good program to present this type of "what it is and why" information in an interesting manner at meetings of other technical and manufacturing groups. Basic educational films would be

ideal for this purpose, and if properly done there is hardly a group, from ACS to Lions Club, which would not give this subject program time.

An additional method of spreading this basic information would be to popularize **Industrial Quality Control** and to bring out annually an issue devoted to just this type of training. If at least 100 extra copies of such an issue were personally distributed by each Section to company heads not familiar with quality methods, it would aid materially in interesting manufacturers who, to date, have never heard of statistical control.

If there is industrial understanding of modern quality control methods, then there will be industrial demand for their use. Once there is this demand, we may be sure there will be adequate training programs and increased development of even more efficient techniques.

AMERICAN SOCIETY NEWS

ANNUAL MEETING — 1948

The second Annual Meeting of the American Society for Quality Control was held at the Engineering Societies Building in New York City on Thursday evening, 17 June, 1948. At that meeting, the following officers were elected by the Society for the fiscal year 1948-49:

President:
Ralph E. Wareham
Vice-President
National Photocolor Corporation
New York, N. Y.

Vice-President:
Wade R. Weaver
Metallurgical Engineer
Republic Steel Corporation
Cleveland, O.

Executive Secretary:
Simon Collier
Director of Quality Control
Johns-Manville Corporation
New York, N. Y.

Treasurer:
Alfred L. Davis
Associate Director—Evening Extension Division
Rochester Institute of Technology
Rochester, N. Y.

Because of the dead-line closing date for text material for the July issue of Industrial Quality Control, a complete report on the Annual Meeting has had to be deferred until the September issue.

AMERICAN SOCIETY MAIL

Effective 1 July, 1948, all mail and other matters formerly addressed to Mr. George D. Edwards as President of the Society, should be addressed to:
Mr. Ralph E. Wareham, President,
305 East 43rd Street
New York 17, N. Y.

Effective as of the same date, all mail and other matters formerly addressed to Mr. Ralph E. Wareham as Executive Secretary of the Society, should be addressed to:

Mr. Simon Collier, Executive Secretary,
22 East 40th Street
New York 16, N. Y.

Effective 1 July, 1948, the corporate address of the Society became:
22 East 40th Street
New York 16, N. Y.

MEMBERSHIP ON THE BOARD OF DIRECTORS

The terms of the representatives of the following Sections on the Board of Directors expired on 30 June, 1948:

Buffalo
Chicago
Dayton
Georgia
Illinois
Iowa
Milwaukee
N. East'n Indiana
Pittsburgh
St. Louis
Southern Tier
Tennessee
Toronto
Washington

Election of Mr. Wade R. Weaver as Vice-President of the Society also rendered the National Directorship of the Ohio Section vacant as of the same date.

In order that the new Board may be completed as early as possible, and particularly that the new Executive Committee may be constituted and begin functioning promptly, all of the above Sections which have not appointed Directors for the forthcoming term are urged to do so immediately and to notify the Executive Secretary of the names and addresses of their selections.

Present Directors are of course eligible to reappointment for succeeding terms where this is the wish of the Section concerned. Under the Constitution, present Directors will continue in office until their successors have been duly appointed and qualified.

MEMBERSHIP ON THE EXECUTIVE COMMITTEE

The term of the Regional Director for the Northern Region expired on 30 June, 1948.

Election of Mr. Wade R. Weaver as Vice-President of the Society rendered the Regional Directorship for the Central Region vacant as of the same date.

As soon as all of the Sections in either of these two Regions, having Directors whose terms expired on 30 June, 1948, have notified the Executive Secretary of appointment and qualification of their new Directors, the Executive Secretary will notify all of the Directors in that Region of their duty to choose a new Regional Director from among their own number.

In those cases where a Regional Director is reappointed as a Director to represent his Section, for the forthcoming term, he is of course again eligible for selection as Regional Director where this is the wish of the Directors concerned.

In order that the new Executive Committee may be constituted and

may begin functioning as promptly as possible, all Sections in the above Regions having Directors whose terms expired on 30 June, 1948 are particularly urged to appoint their new Directors immediately and to notify the Executive Secretary of the names and addresses of their selections.

MORE STRINGENT QUALIFICATIONS FOR SENIOR MEMBERSHIP

Under the provisions of Section **4. d.** of the Constitution, the age and experience qualifications required of applicants for Senior Membership during the fiscal year 1946-47 have been 24 years and 2 years respectively.

Effective 1 July, 1948, the Constitution requires that these ages and experience qualifications be increased to 25 years and 3 years respectively. These new requirements will be in effect throughout the fiscal year 1948-49, at the end of which a further similar increase will be made.

ASQC CONVENTION 1949

The four Sections in the New England Region, namely:

Boston Society for Quality Control
Hartford Society for Measurement and Control
Southern Connecticut Section — American Society for Quality Control
Western Massachusetts Society for Quality Control,

have invited the American Society to hold its next Convention in Boston in the late Winter or early Spring of 1949. This invitation was accepted by the Executive Committee at its meeting on 17 June, 1948.

Practically no detailed plans for the Convention have yet been worked out, but it is expected that a two-day program will be arranged during February, March, or April of 1949. The extraordinary success of both the Chicago and Rochester Conventions insures that those attending the Boston Convention will be guaranteed an enjoyable and worthwhile meeting.

As the detailed plans for the meeting are worked out, announcement will be made of them in subsequent issues of Industrial Quality Control.

ROCHESTER SECTION MAKES BANNER SUSTAINING CONTRIBUTION

MARTIN A. BRUMBAUGH AWARD TO BE INSTITUTED

The Rochester Society for Quality Control has placed itself in the van of Sustaining Contributors by doubling its recent contribution to the American Society. Coming in part from its masterful handling of the Second Convention of the American Society, and in part from its own treasury, this generous gift totaling $2000 from the Rochester Section will be of untold aid in supporting the services of the Society to the entire national membership. It constitutes the largest single contribution so far received for the support of the Society's work.

In making this gift, the Rochester Section has made a suggestion the entire appropriateness of which is so obvious that the Executive Committee has been more than pleased to take immediate steps to effect its adoption.

It is proposed to set aside an appropriate portion of the gift for the support of a cash award to be made each year to the author of that paper published in Industrial Quality Control and judged to have made the greatest contribution to the development of industrial application of quality control. This award is to be known as the Martin A. Brumbaugh Award, in honor of that distinguished Fellow of the Society who founded its magazine in 1944, who published and edited the magazine almost solely by his own efforts during the first several years of its existence, and who served as the first Chairman of the Society's Editorial Board.

The President has been authorized to appoint a committee with the duty of formulating recommendations covering the following points:

1. The proportion of the gift to be set aside for the purpose of the Award;
2. Whether merely the income, or a portion of the principal of this proportion in addition, should be used annually for the purposes of the Award;
3. The cash amount of the Award to be made annually.
4. The conditions under which the annual selection shall be made of the paper to become the basis for the Award.

The plan for the Award will become effective upon Executive Committee approval covering the above points.

EXECUTIVE COMMITTEE MEETS

The Executive Committee of the Society held its final meeting for the 1947-48 fiscal year in New York City on Thursday afternoon, 17 June, 1948. A number of matters came up for consideration and discussion, and several important decisions were reached. One or two of the latter are reported upon in part in this issue of the magazine, but a complete report has had to be deferred until the September issue.

YEAR-BOOK 1947-48

The American Society Year-Book for 1947-48 has now been mailed to all of the members listed therein (listing supposedly up to date as of 1 May, 1948). In addition, it has been mailed to all members joining the American Society after 1 May, 1948 who have paid dues for any portion of the fiscal year 1947-48. Because of the limited number of copies printed, the Year-Book cannot in general be supplied to 1948-49 members who have not paid dues for any portion of the year 1947-48.

Any American Society member who should have received a copy of the Year-Book on the above basis, and who has not received one, is urged to communicate with the Executive Secretary so that the error may be traced and rectified. The Year-Book cannot in general be supplied to non-members.

Members are urged to read carefully the statement on Page 2 of the Year-Book, with regard to the use of the membership list which

it contains, and to guide themselves strictly in accord therewith.

Members are also urged to check carefully the listing of their names in the Year-Book, both in the Alphabetical Index of Members and in the Catalogue of ASQC Sections, and to inform the Executive Secretary promptly of any errors or omissions in the listings. The Executive Secretary will also appreciate being informed of any other errors or omissions which may be noted, so that all may be corrected so far as possible in the 1948-49 Year-Book.

Secretaries and other Officers of Sections are requested to check carefully all information contained in the 1947-48 Year-Book referring to their several Sections, and to notify the Executive Secretary promptly of any errors which they may discover. It is suggested that particular checks be made between Section membership records as of 1 May, 1948, and the Section membership totals recorded in the Summary and Index of ASQC Sections.

It is recognized that errors and omissions may have crept into the Society's records from time to time, and it is hoped that the thorough checking which the Year-Book makes possible may be largely effective in rectifying them.

SHEWHART MEDAL

In June, 1947, the Board of Directors voted establishment of the Shewhart Medal to be awarded "not more than once each year" to an individual who has made a "suitably outstanding contribution to the cause of Quality Control."

The Shewhart Medal Committee was appointed in the Fall of that year to administer all phases of the project. This Committee is composed as follows:

P. L. Alger, Fel. ASQC, Chairman.

C. A. Bicking, Sr. Mem. ASQC.

E. L. Fay, Fel. ASQC.

G. R. Gause, Sr. Mem. ASQC.

I. S. Hoffer, Sr. Mem. ASQC.

A. I. Peterson, Sr. Mem. ASQC.

The Committee has worked out rough designs for two types of medal, — the type which it prefers being somewhat the more expensive in first cost, but not differing in annual cost thereafter. It reported on its progress to the meeting of the Board of Directors in February of this year, and requested the Board's authorization that the Committee undertake itself to raise the funds necessary to finance the project. The Board was pleased to approve the Committee's proposals and to grant the authorization requested, with the understanding that there be no organized solicitation of funds in the name of the Society and that all contributions be strictly on an informal and voluntary basis.

The Committee feels that this project is one in which a large cross-section of the Society's membership should and will wish to have a part. Substantial progress in the raising of funds has already been made. Before inviting any further major subscriptions however, the Committee now proposes that each member of the Society be given opportunity to subscribe to the Fund in such amount, large or small, as he may wish to. The larger the individual subscription, the better pleased the Committee will be of course, but it is particularly hoped that a very large proportion of the members will see their way clear to supporting this project to the extent of subscribing at least $1.00 toward it. All contributors to the Fund will be recorded, and listed in the Year-Book, as Sustaining Contributors to the Society for the year in which their contribution is made.

All contributions in excess of those required to cover the detailed design work, sinking of the die, and other first costs, will be placed in a Fund the income from which will be used for the striking of medals as awarded in subsequent years.

It is hoped that the necessary funds can be raised to complete the design and other work so that the first presentation of the Medal can be made at the Society's Convention in the Spring of 1949.

All contributions should be made payable to the American Society for Quality Control, and should be sent to:

Mr. Alfred L. Davis,
Treasurer ASQC.
Rochester Institute of Technology
Rochester 8, New York

They should be designated for the Shewhart Medal Foundation. It is understood that, being made to the Society, all such contributions are deductible for income tax purposes.

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Courses in Statistical Quality Control

PURDUE COURSE

An eight-day advanced course in statistical quality control will be offered by Purdue University September 9-17 inclusive. This course is intended to meet the needs for additional training of men and women who have had some previous instruction or practical experience in the subject.

Topics to be offered are: review and background of control charts, significance of differences, principles of acceptance sampling, sequential analysis, both attributes and measurements, linear and multiple correlation, analysis of variance, tolerances of fitting parts, chi-square, and use of calculating machines.

Tuition is $100. For additional information, write to Professor Irving W. Burr, Department of Mathematics, Purdue University, Lafayette, Indiana.

MICHIGAN COURSE

The Extension Service of the University of Michigan will offer a 10-day course in Statistical Quality Control August 16-26 inclusive, on the campus in Ann Arbor. This will be the same intensive, practical, non-mathematically technical type of course which was given in Detroit in December 1943 and in more than twenty leading industrial centers during World War II, and which has been given in a slightly expanded form almost if not quite an equal number of times since the war.

Dr. C. C. Craig, Professor of Mathematics and Director of the Statistical Research Laboratory of the University, will be in charge of the course.

TIME—August 16 to 26.

PLACE—University of Michigan Campus, Ann Arbor.

REGISTRATION—$100.00.

For further information, address:
University of Michigan Extension Service
107 Haven Hall
Ann Arbor, Michigan
Attention: Professor C. C. Craig.

TRAINING CONFERENCE ON INDUSTRIAL EXPERIMENTATION

A five-day training conference in Industrial Experimentation will be offered by the Engineering School of Columbia University, New York, September 14-18, 1948. The course is intended to provide both formal and practical insight into fundamentally effective techniques for persons with a background of experience and at least one course in statistics, quality control, or the equivalent.

The subject matter of each day will be treated as a unit, the morning periods given over to the presentation of formal principles and problems, while the afternoons will be conducted as clinic sessions, with specialists from industry as speakers. The topics to be considered include the nature of problems in industrial experimentation; the role of control charts, correlation, analysis of variance and their interrelation in the design of experiment; assumptions underlying analysis of variance, one-way and two-way classifications; Latin squares, factorial designs, sequential methods. There will also be a special session on computing machines at the Watson Scientific Computing Labpratory.

The full-time instructors will be Professors S. B. Littauer, Department of Industrial Engineering; J. Wolfowitz, Department of Mathematical Statistics; and Mr. R. E. Bechhofer, Department of Industrial Engineering, all of Columbia University. The industry specialists will be Dr. Beverly Clarke of Merck and Company, Dr. E. V. Lewis of the Carothers Research Laboratory, E. I. du Pont, Dr. Harry Romig of Bell Telephone Laboratories, Colonel Leslie E. Simon of Army Ordnance, Aberdeen Proving Grounds, and Mr. Ralph E. Wareham of National Photocolor Corporation.

Arrangements have been made for dining as a group at the Men's Faculty Club. Provision has also been made for inexpensive lodging on campus. The fee for the Conference, including all books and supplies and all lunches and dinners at the Men's Faculty Club is $100.00. Enrollment will be limited to 30 persons. Further inquiries and requests for brochures and application may be addressed to Professor S. B. Littauer, Department of Industrial Engineering, Columbia University, New York City 27.

IOWA COURSE

A ten-day intensive training course in **Quality Control by Statistical Methods** will be offered by The State University of Iowa at Iowa City, October 5-15, 1948. This will be an introductory (not an advanced) course which will follow the same general pattern of previous introductory courses.

The tuition fee of $100 per person includes all necessary instructional materials. Room accommodations will be available at the Jefferson Hotel in Iowa City. Reservations should be made by direct correspondence with the hotel. Further inquiries concerning this course should be addressed to: Professor Lloyd A. Knowler, Chairman, Department of Mathematics, The State University of Iowa, Iowa City, Iowa.

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. . . Editorial . . .

In the July, 1947, issue of this magazine there appeared an editorial, the burden of which was a request for a supply of papers with which to create a reserve of publishable material. Volume IV, now completed, is a testimony to the generous response which this request met. Thanks to the co-operation of our contributors, Industrial Quality Control now has in its files or in process an encouraging backlog of manuscripts with which to face the forthcoming issues of Volume V.

Let it not be assumed, however, that papers which should appear in this magazine will automatically come to it. Keeping the files of the editorial office well stocked with challenging papers is a continuing project. Responsibility for channeling likely papers to the magazine must rest on the individual Society member, and particularly on the Program Chairmen of the respective local Sections. To the extent that this responsibility is recognized and activated, Industrial Quality Control will grow in stature and usefulness. To the extent that it is neglected, the magazine will fall short of the service it could render.

Industry today is merely on the threshold of the full potential for the fruitful use of statistical techniques which it will someday achieve. It must be the role of the American Society for Quality Control, and particularly of its journal, Industrial Quality Control, to encourage, nurture, and support an ever widening acceptance, use, and understanding of the science of statistics applied to industrial problems. As new fields of application open, as new strategy is devised to meet these fresh challenges, and as existing techniques are refined and strengthened by fundamental research and maturing experience in practical applications, this magazine should become a focal point for reporting and recording these advances. It will serve in this capacity to the extent that the men who are doing the work make available to it the results of their experience.

On the other hand, Industrial Quality Control owes to its readers the duty of seeing that material which it publishes is technically correct and operationally meaningful. The editorial policy with regard to material used must be to aim at a level well above triviality and pedantry and well below the level of pure sophistication and theory. Responsibility for keeping the magazine on the firm ground of sound, readable, and instructive articles rests jointly with the Editorial Board and the contributors. Co-operation between these two channels that ultimately converge in publication of a paper has been most encouraging. Without the continuance of such co-operation the role of Editorial Chairman would be a hopeless and futile one.

The woods are full of good, challenging topics suitable for articles in Industrial Quality Control, and they are going to get fuller as time goes on! Keep the papers developing these topics rolling in! We probably won't be able to use **all** of them, but with your co-operation we shall do our level best to use **most** of them and to see that what we **do** use are the kind of papers that will be worth reading!

Mason E. Wescott.

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Book Review

ELEMENTS OF NOMOGRAPHY
Raymond D. Douglass
Professor of Mathematics
and
Douglas P. Adams
Assistant Professor of Graphics
Massachusetts Institute of Technology.

McGraw-Hill, New York, 1947; 209 pp; $3.50. Review by R. H. Colvin, Burd Piston Ring Company, Rockford, Illinois.

The authors state in their preface: "The book is written to serve the needs of all students of the elementary subject and especially of those who find it necessary to study by themselves and who accordingly wish a careful, thorough, practical presentation of the theory using elementary tools. It is based upon the point of view that the construction of nomographic charts for ordinary purposes is an extremely practical task."

This statement outlines adequately the purpose and plan of the book. The first six chapters are quite elementary, but should be given careful consideration by anyone who wishes to make a study of nomographic charts. It is far from being as elementary as the authors profess.

After Chapter 6, a very fine development is made of simple adjacent scale charts, followed by simple parallel scale alignment diagrams of an increasingly complicated nature. The development here presents an excellent system of a methodical and logical form for the computation of all the data necessary to construct the chart for a given problem. Special commendation should be given the authors for the use of simplified substitution formulas for making the explanation easier to follow and the final solution easier to obtain.

Next, the book considers the N type alignment charts with all of their variations. Here again, the same methodical computation form is used which, if followed, takes all the guess work out of the construction of these types of charts.

Chapters 16 and 17 concern the hexagonal and circular charts, and here, although the treatise is rather brief, there is sufficient information for anyone who cares to dig into it to construct one of these charts. A thorough understanding of the preceding work is a must for this advanced work.

Chapter 18 deals with compound alignment diagrams, graphical devices and analytic geometry diagrams; also a miscellaneous assortment including the authors' special alignment diagram for the equation $X^2 + d\,X + e = 0$, consisting of two parallel straight scales and a closed elliptical curve.

Each of the chapters is followed by exercises which are very helpful to the understanding of the content matter.

It is the reviewer's opinion that on the whole this book gives a very fine treatise for the student who wishes to obtain a good ground work in the construction of nomographical charts. It should be carefully followed from beginning to end, and a thorough understanding of each chapter arrived at before the next one is tackled.

However, to quote the authors again, "The successful rule of thumb or short cut nomographer is not to be criticized for his approach, but rather to be encouraged by clear expositions to observe how his special knowledge is merely a valid part of more extensive and more useful general practices. His newly acquired information will quickly save him more time than ever."

For the practical engineer who does not have an adequate staff of assistants, and who wants to save some time by using a nomograph (alignment chart), some very useful and very practical short cut methods can be used. This reviewer feels that the authors could do well to prepare a second book, using their splendid approach in this one, to help the practical man when he requires an alignment chart and does not have the time to delve into all of the basic knowledge necessary to produce a perfect chart. Essentially, all that any alignment chart can do is to add values as we do when we wish to measure 18 inches and have only a 12 inch rule, or as we add logarithms on a slide rule, which is an adjustable nomograph.

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